# CHEMICAL & METALLURGICAL ENGINEERING

DECEMBER, 1933

VOLUME FORTY — NUMBER TWELVE


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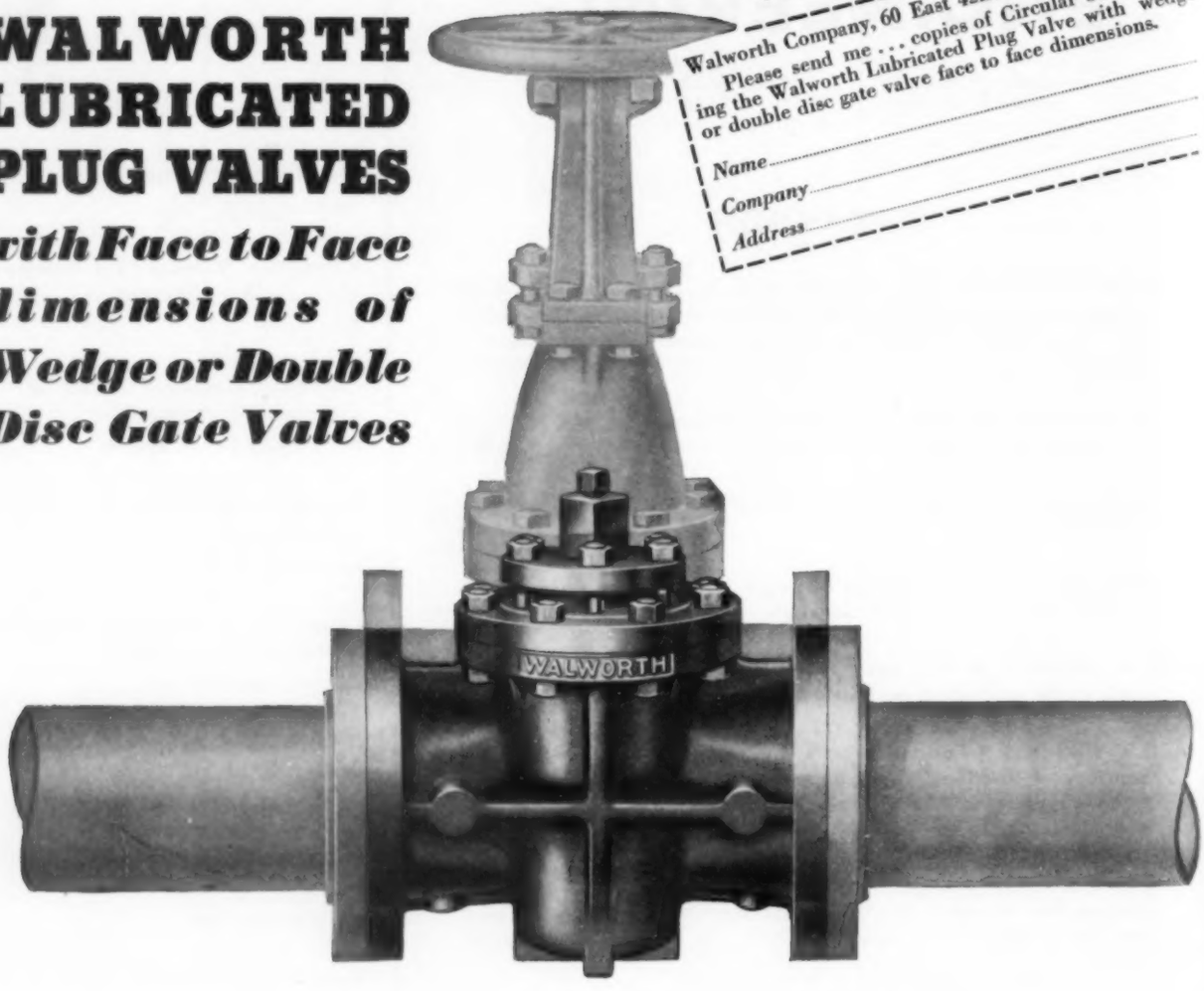


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## HOW CONGRESS CAN HELP INDUSTRY

CONGRESS will soon convene, confronted with many problems, all of them difficult and many of concern for process industries. Some of these problems are wholly insoluble by legislation. But that will not prevent Congressional debate, mad proposals, perhaps even some absurd enactments. On the whole, however, Federal legislation is more needed than usual. Being by nature hopeful, we do not on this occasion, at least, endorse the cynic's common recommendation: "Oh, let's repeal Congress."

Legislation affecting industry will take on three separate aspects. It will deal with fiscal (and tax) matters; it will concern the regulation of industry; it will attempt further relief of unemployment. All will be important, maybe beneficial if settled in a statesmanlike manner, but sure to be disturbing while demagogic debate rages. There is little chance that we can wholly escape the demagogue, though all sincerely hope to be spared the enactment of his theories into other new and dangerous laws.

Tax adjustments proposed are already in large measure announced. They follow logically the lines expected after the Senate investigations. But they do not yet wholly reflect the more radical views on new sources of needed revenue. One must here remember that liquor taxes, large though they seem in prospect, will yield little more than replacement revenue, offsetting other taxes automatically ended by Repeal. Industry is likely to be the target of oratory, if not worse, when attempt is made to balance the budgets, normal and extraordinary. New business taxes seem inevitable.

Sound money is a sure topic for debate. Chemical industry is concerned in this mainly as it affects public confidence and psychology of buyers—directly those who want new producers' goods and new capital investment, secondarily those who represent the ultimate user of consumers' goods. But more important, and really helpful, will be the revision of the Securities Act which has wholly protected investors, a desirable result, by a wholly bad method, the destruction of both will and opportunity of industry to borrow new capital. Congress should act here quickly and helpfully.

Many variations of formula will undoubtedly be proposed for the regulatory agencies, N.R.A. and A.A.A. The President may have to still the howling by throwing to the wolves some of the theories previously attempted. Late developments suggest the hope that cooperation with industry may be made a real part and less emphasis be given to bureaucratic regulation and censorship. However, it seems certain that the President's influence will continue to be exerted in support of the more socialistic concept that uplift of the underprivileged is a prime duty of government.

Before January it will be well for thoughtful executives and engineers of process industries to exert their personal influence on all these matters. They can do so best through senators and congressmen by asking less for specific measures and more for the general principles. Above all, it is well to ask these legislators to return to their tasks, seeking conservative progress, neither greater speed forward nor wholly a turning back to old conventional ways. Needs change with times, but law should not outrun public ability to understand and to conform.

And with all *Chem. & Met.* wishes each reader A Merry Christmas.

**REPEAL** *means* **REVIVAL** *of another Process Industry*

# DISTILLING BEVERAGES FROM GRAIN

By GUSTAVE T. REICH
*Pennsylvania Sugar Co., Philadelphia, Pa.*

WITH REPEAL of the Eighteenth Amendment a *fait accompli,* many people will consider it a propitious time to enter or re-enter the manufacture of alcohol in the form of whiskey, gin or spirits. Considerable strides have been made along technical lines since 1918 and under the present business conditions only the manufacturer who is able to erect a well designed plant, applying on a large production scale continuous beer and rectifying stills and other efficient chemical engineering equipment and having fermentation and other process steps under strict chemical control can hope to survive the keen competition ahead.

Chiefly grain will be used for the manufacture of beverage alcohol, but there are, of course, several other processes by which alcohol can be produced economically. These belong to two groups, one is by fermentation and the other is by synthesis. In the first group, the raw materials are grain, fruit, molasses and cellulosic materials, while the second group embraces ethylene, natural or coke-oven gas, calcium carbide and carbon monoxide. The present article will deal mainly with the manufacture of alcohol from grain but Fig. 2, shows the general process steps with various raw materials. A second article discussing alcohol from molasses will appear in a later issue.

Before Prohibition ethyl alcohol produced from agricultural products was made chiefly from malt, wheat, rye, barley, corn, and oats. (See Tables I, II, and III.) The theoretical and practical yields of alcohol from these raw materials are as follows:

| | Lb. per bu. | Fermentable sugar and starch (Per Cent) | Fermentable sugar & starch per lb. per bu. | Absolute alc. theoretically lb. per bu. | Alcohol practically proof gals. per bu. |
|---|---|---|---|---|---|
| Barley | 48 | 65.5 | 31.4 | 17.75 | 4.50 |
| Malt | 34 | 60.6 | 20.6 | 11.57 | 3.00 |
| Wheat | 60 | 64.8 | 38.9 | 22.02 | 5.90 |
| Maize (Indian corn) | 56 | 66.0 | 36.9 | 20.94 | 5.00 |
| Rye | 56 | 59.3 | 33.2 | 18.75 | 4.75 |

The first process step in the manufacture of alcohol from grain is the milling, which consists of conveying, cleaning and grinding. The distiller has considerable flexibility in choosing the right equipment depending on the capital and floor space available and quality of product desired.

The grain is received, usually by rail, in cars containing approximately 600 bu. It is conveyed to a hopper scale and from there it passes first through a separator before it is stored in iron, wood, or reinforced concrete silos. In this separator most of the dirt and dust is carried away into a dust collector. The partially cleaned grain is stored in silos and from there is conveyed to the milling department. All the grain entering the mill is weighed and records are kept according to Government regulations. The grain is cleaned a second time and before being ground to the desired fineness, it passes over a magnetic separator for the removal of metallic substances which might injure the mills.

When constructing a distillery, careful study should be made of the grinding equipment as we have three types of mills from which to choose, viz., the extensively used roller mill, the attrition mill and the hammer mill. Each one has its defects as well as its good points. When it comes to the power requirement, the roller mill is by far the most efficient. But in addition to power requirement consideration should be given to the amount of fine material present in the ground material as well as floor space available.

The old type of distillery with its large and wasteful layout and floor space, contrasts with the compactness noted in distilleries under construction at present. In some instances today the milling equipment is being erected in the same building with the mashing and fermenting tubs. Because of smaller investment it sometimes pays to be quite liberal with mechanical conveyors rather than to build a high gravity-flow milling plant.

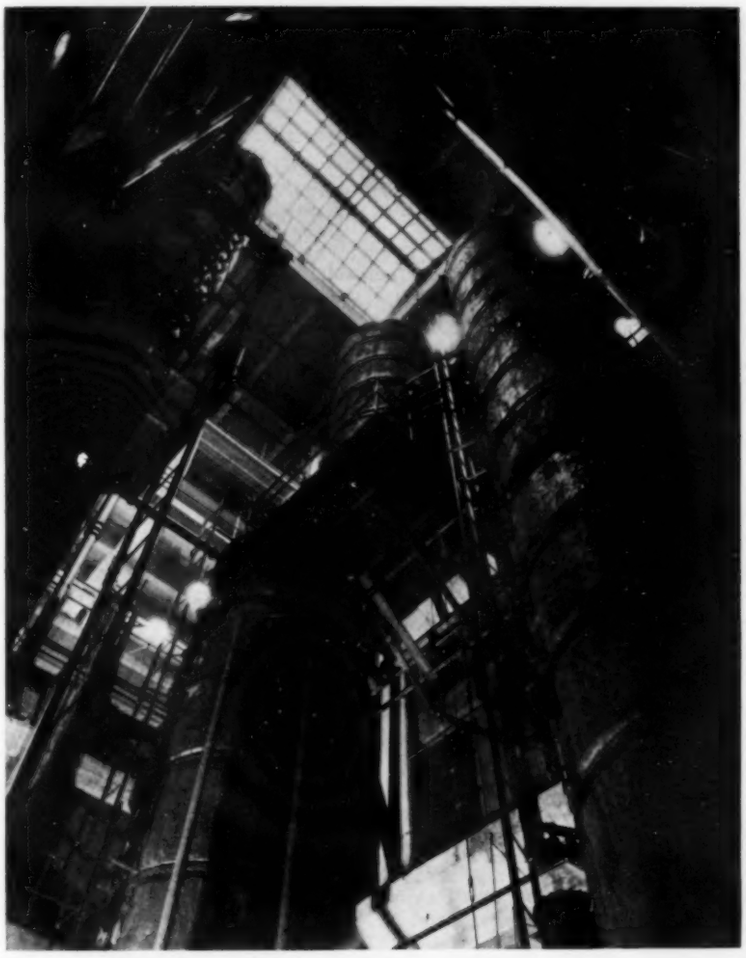


**Fig. 1—Rectifying columns in a modern distillery**

As there are several varieties of yeast, it is important to choose a type which is capable of producing the largest quantity of alcohol under desired conditions. We have high and low temperature yeasts, some for sour, sweet or hops mashes, while others are capable of being active in high density mashes. Regardless of which type of yeast is selected, it is of a prime importance to start only with pure culture yeast, which is used exclusively in the molasses distilleries in this country. Before Prohibition, the typical distiller considered the preparation of his yeast a great secret and attributed every conceivable result to the special method he used in its cultivation. The progressive distiller will start with a pure culture yeast and propagate it in the properly designed pure culture apparatus and acclimate it to the special type of mash he desires to ferment.

The yeast mash containing half rye meal and half malt is gelatinized and saccharified at a temperature of from 40 to 158 deg. F. First the rye is run into hot water slowly, stirring it vigorously and then the malt is added, watching carefully meanwhile, that the temperature shall not drop below 122 deg. F. While slowly stirring the mash is heated to 143 to 145 deg. F. within one hour and the sides and rakes are washed down with a little hot water. The mash stands at this temperature for approximately one hour to complete the saccharification. A density of 23 to 25 deg. Balling is desirable. At the end of the hour, the mash is prepared for the souring by inoculating it with lactic acid bacteria. It requires 24 to 36 hours to obtain an acidity of 1.8 deg. to 2.1 deg. normal, while a temperature of above 120 deg. F. is maintained. When the proper degree of acidity has been reached, rakes are started and the temperature raised to 170 deg. F. and held for about half an hour. Part of the hot mash is removed to be used as a starter for the next batch while the remainder is rapidly cooled, by passing cold water through the heating coils, to a temperature of 70 to 75 deg. F. and is inoculated with the pure culture yeast.

The pure culture yeast may be propagated either in suitably designed machines such as Magne's, or if carefully attended in wooden or iron yeast tubs. When the density of the first mash has dropped to 5 to 6 deg. Balling, it is transferred to a larger yeast tub stocked with a sterilized malt donna. After several hours working it is used in the fermenters. Its density is from 7 to 9 deg. Balling and acidity, 0.14-0.16 normal.

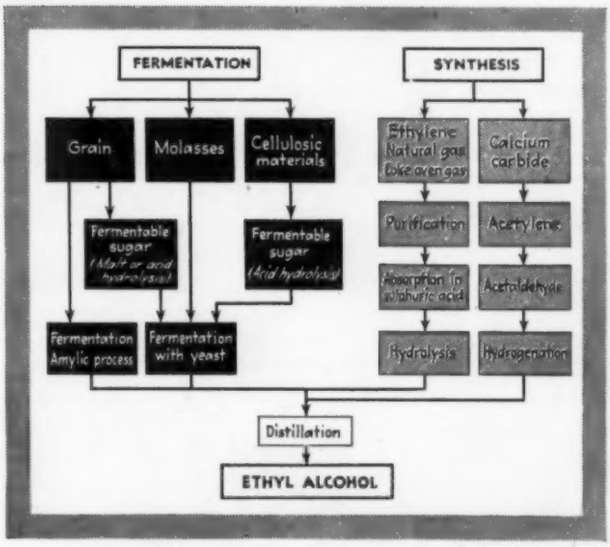



**Fig. 2—Sources and processes for ethyl alcohol production**

In the manufacture of grain alcohol, it is important to know whether the product is to be converted into whiskey or spirits; also the size of the distillery and raw materials used. Small distilleries will undoubtedly be equipped with open mash tubs while larger distilleries may operate pressure cookers exclusively. However open

**Table I—Quantities of Grain Used in the Production of Alcohol and Other Distilled Spirits**

| Fiscal Years | Malt (Bu.) | Wheat (Bu.) | Barley (Bu.) | Rye (Bu.) | Corn (Bu.) | Oats (Bu.) | Others Materials (Bu.) |
|---|---|---|---|---|---|---|---|
| 1910 | 3,704,740 | 10,316 | 2,733 | 5,042,741 | 20,547,427 | 11,502 | 8,248 |
| 1912 | 4,075,991 | 25,505 | 1,943 | 5,599,667 | 23,016,759 | 6,563 | 50,576 |
| 1914 | 3,938,715 | 10,582 | 2,072 | 5,341,931 | 21,315,699 | 5,654 | 64,896 |
| 1916 | 4,480,588 | 3,373 | 148 | 3,116,612 | 32,069,542 | 9,807 | 68,822 |
| 1918 | 1,689,677 | ..... | .... | 248,864 | 14,544,545 | ..... | 172,039 |
| 1920 | 215,072 | ..... | .... | 50,077 | 1,057,519 | ..... | 51,760 |
| 1922 | 679,697 | ..... | .... | 84,876 | 3,093,065 | ..... | 4,097,905 |
| 1924 | 1,059,985 | ..... | .... | 91,065 | 4,835,139 | ..... | 2,691,070 |
| 1926 | 641,032 | ..... | .... | 12,678 | 7,948,184 | ..... | 26,621 |
| 1928 | 385,238 | ..... | .... | 6,579 | 6,189,264 | ..... | 123,624 |
| 1930 | 646,574 | 11,990 | 21,320 | 208,209(1) | 9,966,336 | ..... | 19,144 |
| 1932[2] | 505,613 | 3,311,441 | .... | 217,934 | 4,848,133 | ..... | 2,478 |

(1) 1931—6,385,365 bu. (2) Year 1932 figures include 211,675 lbs. of corn 19,865,419 lbs. of wheat, 150,619 lbs. of malt, and 20,103,526 lbs of hydrol acids used at chemical plants producing butyl alcohol, acetone, and ethyl alcohol.

mash tubs are sometimes preferred in distilleries mashing 1,000 to 2,000 bu. per day. Here we have two different opinions to consider: one claims that in order to make a good grade of whiskey open mash tubs should be used while others claim to get just as good results with pressure cookers. That a much better yield of alcohol is obtained from a vacuum cooker can not be doubted, but as to the quality of the final product, a great deal depends on the mode of cooking, the proportion of ingredients, the yeast, and the method of fermentation and still construction.

Cooking and mashing generally refer to the series of process steps in which the starch cells are ruptured to produce a perfect starch paste which through enzymatic action is converted into fermentable sugar. The rupture of the starch cells depends on the fineness of the grain, time and temperature. The more finely ground the grain, up to the point of becoming flour, the better will be the rupture of the starch and a perfect starch paste will be produced. The grain should be such that the recovery of the insoluble solids from the slop will be practicable without impairing the yield of alcohol. Another advantage of finely ground grain is that the quantity of malt required for hydrolyzing purposes can be reduced.

In this country malting is not carried out in the distilleries since malt is purchased from regular malting plants. While any grain can be used for the preparation of malt, from a practical standpoint barley is the most suitable for this purpose. A bushel of barley, which weighs 48 lb., yields 34 lb.—also a bushel—of dried malt. The value of malt from a distiller's standpoint is judged by its diastatic power and extract. The whole malting process aims to develop a malt of a very high diastatic value. The diastase is an enzyme and converts the starch of the grain, during the mashing into maltose and dextrin, which are fermentable and yield alcohol. In purchasing malt, a diastatic value of 1,350 to 1,450 is demanded on the Lintner's scale, i.e. 100 lb. of dry malt will invert 1,350 to 1,450 lb. of soluble starch.

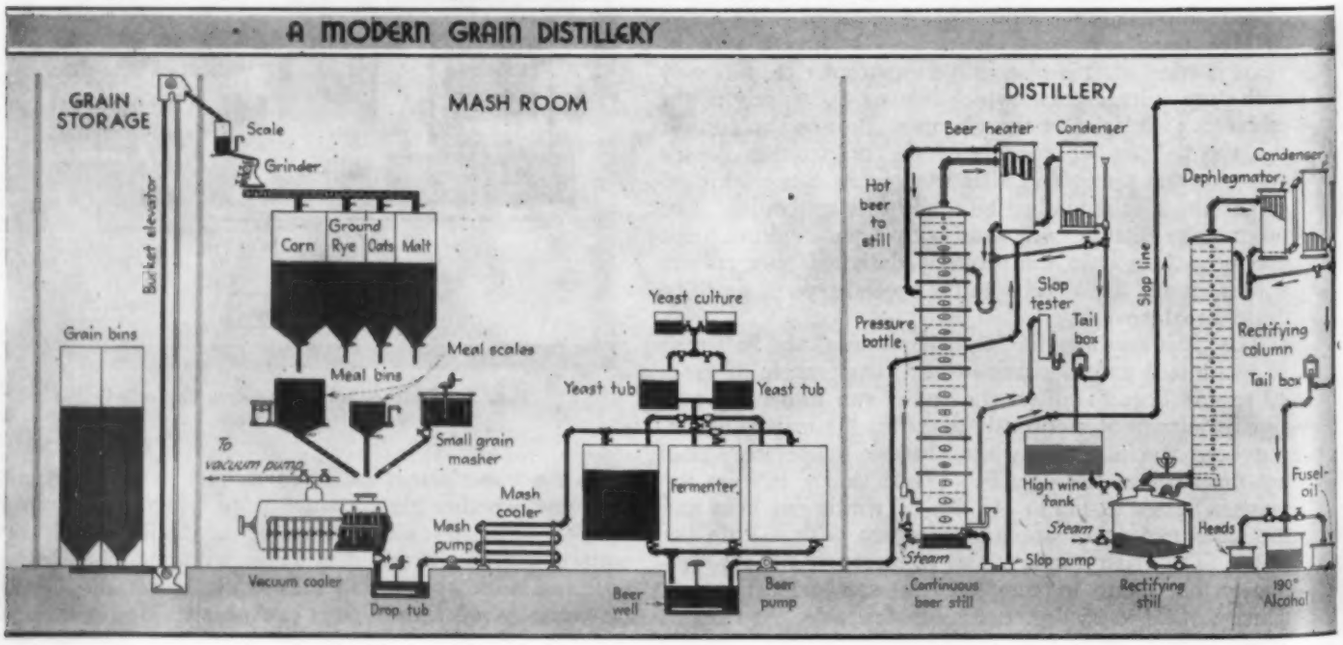
The function of the malt is to liquefy and saccharify the starch. Each action is influenced by the temperature. The diastase of the malt has the greatest saccharifying property between 118 deg. to 130 deg. F. and its strongest liquefying power, around 158 deg. F. The judicious use of these above temperature passages presages a good yield of alcohol.

The flow diagrams in Fig. 4 illustrate the way a typical grain distillery carries out these processes, depending largely on the type of equipment used.

The open mash tub is a cylindrical vertical copper or steel vessel with flat bottom and domed top. Usually it is provided with stirring rakes, copper coils, to be used for heating and cooking purposes, and vents for the escape of steam. Fig. 5 shows such a mash tub.

Hot water in the amount of 20 to 24 gal. per bu. of grain and at a temperature from 100 to 120 deg. F. is run into the tub. The addition of grain depends on whether a rye mash or corn mash is desired. If rye is mashed, the procedure must be adjusted according to whether it has a high gluten content or the rye malt has a low diastatic capacity and fluidity. Generally, half of the finely ground rye and all of the malt (approximately 15 to 25 per cent of the weight of rye) are mixed thoroughly and slowly run into the water. During the addition of the meal the rakes are speeded up to prevent the formation of lumps. After the addition of this mixture, the remainder of rye is added slowly so that all of the meal is run in within 30 to 45 minutes. Afterwards the temperature is held at 110 deg. F. for at least ten minutes with the rakes revolving slowly. The temperature of

**Fig. 3—Complete flowsheet and equipment required for distilling beverages from grain in a modern plant**



the mash is now raised by admitting steam to the coil until 145 deg. F. is reached. The mash is held at this temperature from 15 to 25 minutes and finally raised to 152 to 154 deg. F. and held there from 30 to 45 minutes. The saccharified mash is cooled to about 75 deg. F. and is pumped to the fermenters. Instead of adding all the rye meal at the beginning before the temperature is raised above 110 deg. F., we may also add half of the rye, after the mash reached a temperature of 152 deg. to 154 deg. F. and is cooled down to 150 deg. F. This procedure depends entirely on the quality of product desired.

Corn mash requires a much higher temperature since the gelatinization of its starch is much more difficult. In this case, 7 to 10 per cent of the total malt required, based upon the corn to be mashed, is added first to water at a temperature of 130 to 140 deg. F. and afterwards all the corn meal. While the rakes are in motion, the temperature is raised within 30 to 35 minutes to 200 deg. F. and is maintained there for 10 to 15 minutes. The gelatinized mass is cooled rapidly within 20 to 25 minutes, to 158 deg. F. As soon as this temperature is reached, the remainder of the malt is added slowly in order that the temperature shall not drop below 152 deg. F. If rye to the amount of 10 to 20 per cent of corn is used, it is added at a temperature of 156 deg. F. and precaution taken that the mash temperature shall not be below 150 deg. F. Where cold water is available, the mash is cooled to 100 to 110 deg. F. and when mixed with water will have the proper temperature for the fermenters.

While in the open mash tub, the cooking, saccharification and cooling is done under atmospheric pressure, in the vacuum cookers, cooking is carried on under pressure and the cooling effected under vacuum.

The vacuum cooker is a cylindrical tank supported on legs, provided with a shaft and stirrers. Capacity ranges from 2,000 to 10,000 gal. capable of processing 50 to 250 bu. of grain. They stand a pressure of 100 lb. and are provided with several live steam inlet pipes, vent and vacuum lines, also opening for the charging of dry grain and wet malt from the small grain masher. Customary pressure and vacuum relief valves and thermometers are also attached.

The cookers are charged with 20 gal. of water per bu. of grain. Then steam is applied and the temperature raised up to 300 deg. F., or 50 to 65 lb. pressure. During the heating a great deal of live steam is condensed so that at the end of the mashing, the original liquid volume has increased to 22 gal. per bu. After cooking, the blow out pipe is opened to reduce the pressure. Then the vacuum line is opened and by means of the vacuum pump, the mash temperature is reduced to 152 deg. F. when the malt mash in liquid form is added from the small grain masher. The amount of malt used to the grain is from 7 to 15 per cent. After allowing sufficient time for the saccharification, as has been described for the open mash tub, the thick gelatinized mass is dropped into the "drop tub" and from there is pumped through coolers into the fermenters. For the cooling of the mash the distiller employs either a double pipe cooler or a shell and tube cooler, the latter being used extensively abroad. For the dilution of the mash, water or a mixture of water and slop are used. The latter procedure is applied by Bourbon mashes or where the slop is to be concentrated and sold for feeding purposes. One cooker is capable of handling 8 to 10 charges per day.

PROPERLY gelatinized and hydrolyzed the grain will contain most of its starch in the form of maltose and dextrine which with the addition of yeast is easily fermentable. Wood, enamel-lined or steel tanks can be used for the fermentation of the mash. Small distilleries will use wooden fermenters but the progressive distiller prefers closed steel tanks, provided they have tapered bottom and top as illustrated. The advantage of the closed fermenters is the increase of the yield of alcohol from 1 to 2 per cent and the ease of the recovery of carbon dioxide for the manufacture of liquid and solid $CO_2$ as described by the author in *Chem. & Met.*, Vol. 38, 1931.

The mash coming from the mash tub or cooker is too concentrated to be fermented easily. Therefore, it is diluted with water or water and a slop so that its fermentable sugar content varies from 7.5 to 11 per cent. This is equivalent to from 30 to 45 gal. of beer per bu. of grain. The concentration depends a great deal on

**Table II—Distilled Spirits Produced During the Fiscal Years 1910 to 1932**
(In Tax Gallons)

| Fiscal Year | Whiskey | Rum | Gin | Brandy | Alcohol | Aggregate |
|---|---|---|---|---|---|---|
| 1910 | 82,463,894 | 2,253,949 | 2,985,435 | 7,656,433 | 68,534,247 | 163,893,958 |
| 1912 | 98,209,574 | 2,577,861 | 3,577,861 | 9,321,823 | 73,630,032 | 187,571,805 |
| 1914 | 88,698,797 | 3,026,085 | 4,012,542 | 7,307,897 | 78,874,219 | 181,919,540 |
| 1916 | 59,240,671 | 2,986,940 | 4,118,064 | 4,159,351 | 182,778,245 | 253,283,273 |
| 1918 | 17,383,511 | 1,526,743 | 4,178,538 | 5,357,325 | 150,387,680 | 178,833,797 |
| 1920 | 234,705 | 944,916 | ..... | 1,649,445 | 98,436,170 | 101,265,236 |
| 1922 | 315,799 | 864,332 | ..... | 1,077,063 | 79,906,101 | 82,163,295 |
| 1924 | ..... | 784,698 | ..... | 847,104 | 135,897,725 | 137,529,527 |
| 1926 | ..... | 894,306 | ..... | 643,968 | 202,271,670 | 203,809,945 |
| 1928 | ..... | 953,350 | ..... | *411,515 | 169,149,904 | 170,514,769 |
| 1930 | 1,998,947 | 982,781 | ..... | 416,043 | 191,859,342 | 195,257,113 |
| 1932 | 1,711,028 | 1,097,777 | ..... | 630,786 | 146,950,912 | 150,390,503 |

*Brandy manufactured in 1929—1,194,292 tax gal.

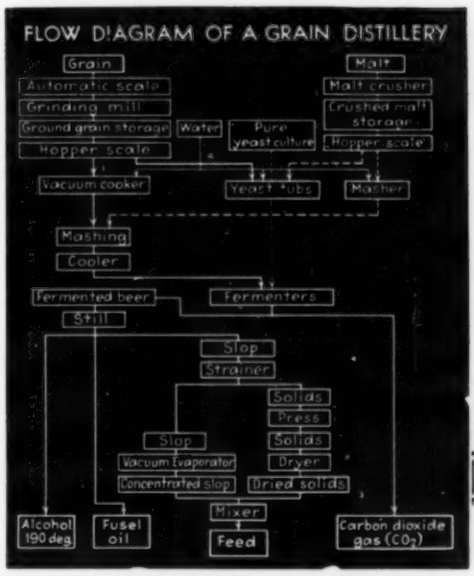
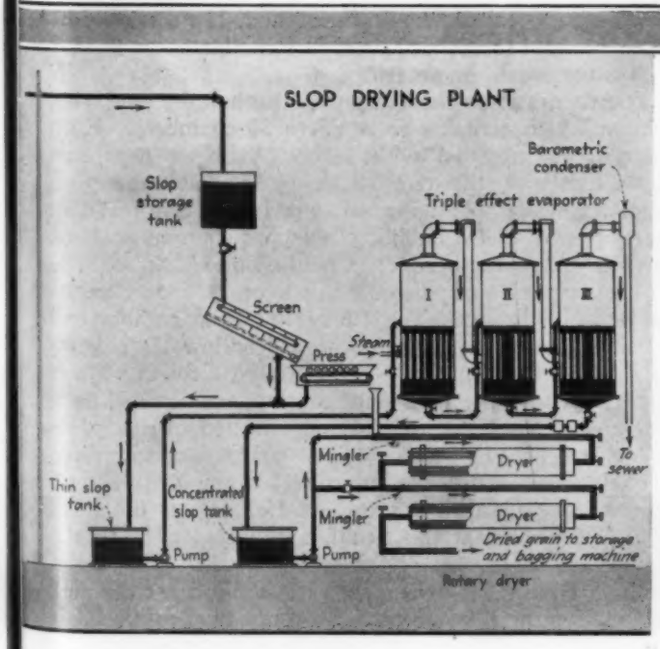



**Fig. 4—Schematic diagram of distillery as shown in Fig. 3**



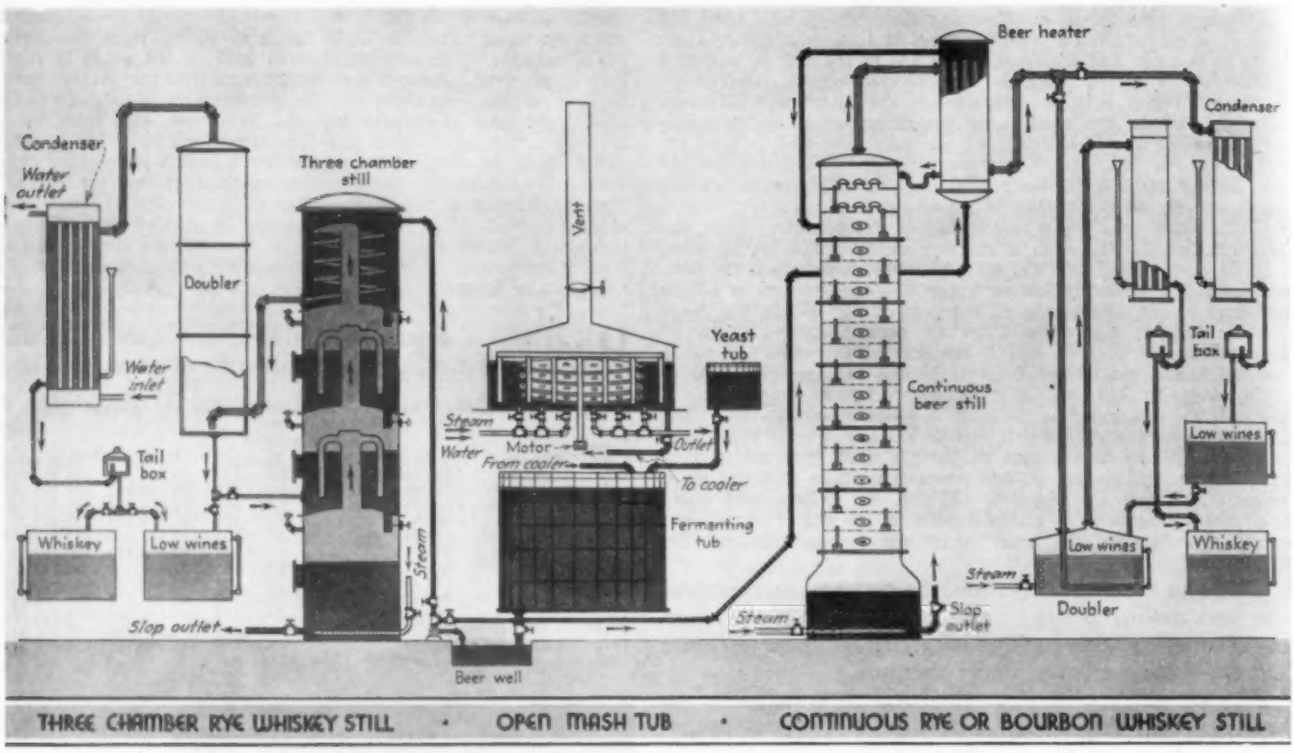



**Fig. 5—Details of equipment featured in modern American distillery**

whether or not the dealcoholized beer "slop" has to be recovered. The higher the dilution the less economical is the recovery of slop. An average mash will have a density of 15 to 18 deg. Balling and the temperature during the fermentation depends on the density of the mash, setting temperature and yeast. On an average, 56 to 65 hours are required to reduce the density from 10 or 12 deg. Balling to below 0.5 deg. and the acidity of a corn mash increases from 0.045 to 0.85 normal. To insure an even rate of fermentation, a temperature of approximately 70 deg. F. should be maintained in the fermenting room.

Large distilleries mashing from 2,000 to 20,000 bu. of grain per day will use only continuous stills or a combination of a continuous beer still and batch rectifying still. The latter combination is shown in Fig. 3 on a preceding page.

The operation of the continuous beer still is identical on either grain or molasses. The fermented mash is dropped into the beer well and from there pumped continuously at a uniform rate and delivered to the elevated beer feed tank. This tank is provided with an overflow pipe and is connected to the suction pipe of the beer pump.

The fermented mash flows continuously by gravity from the beer feed tank to the beer heater. A feed gage placed in the line provides means for observing and regulating the rate of flow of fermented mash to the beer column. The fermented mash passing through the beer heater is heated through the tubes of the reflux condenser by vapors passing through the inter-tubular space. The pre-heated beer is fed into the beer still, which is provided with a beer heater, condenser, live steam line, and is regulated by testing the alcoholic strength of liquid. A special "slop tester" connected to the base of the still serves to prevent the loss of alcohol in the "slop" discharged from the still.

The function of the beer still is to separate and concentrate the 5 to 8 per cent alcohol contained in the fermented mash. The distillate at from 100 to 140 deg. proof strength is condensed and stored and rectified in the intermittent rectifying still (*Chem. & Met.*, Vol. 36).

The rectifying still consists of the kettle, a rectifying column, dephlegmator and a condenser. The kettle, which may be horizontal or upright, is provided with closed steam coils, pressure and vacuum valves, and a glass gage. The still is charged with the distillate from the beer still, called "high wines" and, if necessary, its proof reduced to 100 deg., and in some instances treated with caustic soda or potash.

The vapors from the kettle pass through the rectifying column which contains from 25 to 50 chambers. Each chamber is provided with several bubbling caps and connected with the one above by a downtake pipe. Lately, considerable improvements have been made in the design of these bubbling caps, which may be long, trays with saw-tooth edges, straight slotted, slotted giving the vapors a zig-zag direction, or they may be of the small bell type. The function of the column and dephlegmator is to separate "heads" or low boiling impurities from the partially concentrated alcohol. These impurities, together with some alcohol, are distilled first, then cooled by the condenser and collected in the "aldehyde'" or "heads" tank. The partially concentrated alcohol, freed from these impurities, is now distilled and vapors refluxed until a proof of 190 deg. is obtained. The pure alcohol at this proof is collected until all the alcohol has been recovered from the kettle. Ultimately, the high boiling impurities such as fusel oil are distilled off. The pure 190 deg. proof alcohol thus produced is

sold as spirit to be used for cutting aged whiskey or applied for other industrial purposes.

Many experiments were made to supplant the three-chamber rye whiskey still illustrated in Fig. 5 with the continuous still also shown in Fig. 5 and known as the "Bourbon Still." So far, however, no conclusive results can be recorded, although the continuous still is finding more favor among the larger distilleries owing to its ease of operation.

As with all whiskies, the bouquet is the governing factor and several distilleries to be erected or under construction, favor the three-chamber still because it is claimed to produce a better grade of heavy bodied and highly flavored whiskey. Its operation will be described briefly.

The beer is pumped into the top chamber of the column, which acts as a beer heater and dephlegmator. Thence it is drawn periodically every 15 to 20 minutes, from chamber to chamber, until it is completely dealcoholized as it reaches the lower slop chamber. The slop is utilized for feed as will be described later.

The alcoholic vapors passing through the beer heater go into the doubler, boiling out the low wines, thence to the condenser and the distillate collected as "high wines" or whiskey.

From a fuel economy standpoint, this type of still is not very efficient, but the product is excellent. There is a recent tendency to use heat exchangers more liberally, resulting in a fuel economy of 20 to 30 per cent.

Fig. 5 shows a continuous still operated on the same principle as the continuous beer still shown in Fig. 3.

All the features of heat economy applied in the large continuous still are also applied here. The upper chambers of this column are provided with bubbling caps while the lower chambers containing perforated plates also have down pipes. The beer is pumped first through the tubular beer heater overflowing at the top and enters the column on the third or fourth plate. The alcohol vapors pass first into the beer heater and then they may either go to the doubler or to the low wine condenser. The doubler is either a horizontal tank or a vertical tank, crowned, provided with a perforated pipe reaching to its bottom through which the alcohol vapor coming from the still passes through the low wine, thus producing a very highly flavored, heavy bodied product. To prevent condensation, the doubler contains a heating coil, usually of the "scroll type" which is controlled to prevent excessive condensation of the distillate. The vapors from the doubler are condensed and collected in the "whiskey" storage tank.

Grains contain quite a high percentage of oil. Corn, which is used most extensively has an oil content of 4.5 to 5.5 per cent. Owing to the poor quality of its oil, corn is not generally degerminated but the oil is recovered in its dried slop. The processing of slop consists of the following steps: (1). Separation of the suspended solids from the liquids. (2). Removal of excess liquid from the solid in presses. (3). Concentrating the thin clear slop. (4). Drying the solid and mixing with the concentrated slop. (5). Bagging.

As the returns from the dried slop reduce considerably the cost of alcohol, a brief description follows:

The fermented beer, after passing through the still, is dealcoholized and is called "slop." This slop contains various amounts of solids in suspension and in solution depending on the kind of grain mashed, its quality and the concentration of the slop. A rye mash yields approximately 9-9.5 lb. of dried feed per bu. of grain; Bourbon mash from 11 to 11.5 lb. and spirit mash 11.2 to 11.5 lb. respectively.

The slop coming from the beer still, passes first into a traveling screen, a long inclined screen box, in which the suspended solids are separated from the liquid. The solids then pass into the filtering machine, where they are de-watered and ultimately put into the rotary dryer.

After the separation of the solid from the liquid, the distilleries usually run their thin slop to waste and recover the suspended solids in dried form except where the health authorities prohibit their doing so. The present tendency is to recover all the slop. The thin slop is concentrated in a triple or quadruple effect evaporator to a density of 25 to 30 per cent solids. This syrup is mixed with the solids and dried if necessary in several stages in rotary dryers. The dryers may be heated directly or by rotary steam tube dryers depending on the quality of feed desired and whether the thin slop is wasted or also recovered. In distilleries mashing corn, approximately 18 to 19 lb. of feed per bu. of grain is recovered provided all the slop is being processed.

Quite frequently distillery slop contains 35 to 37 per cent of protein while the fat runs from 10 to 13 per cent depending largely on the condition and moisture

**Fig. 6—Ingot iron fermenters, of 100,000 gal. capacity, with closed tops for $CO_2$ recovery**

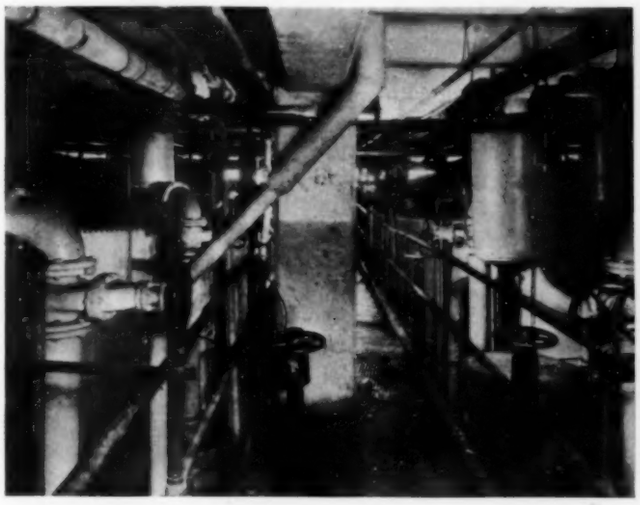
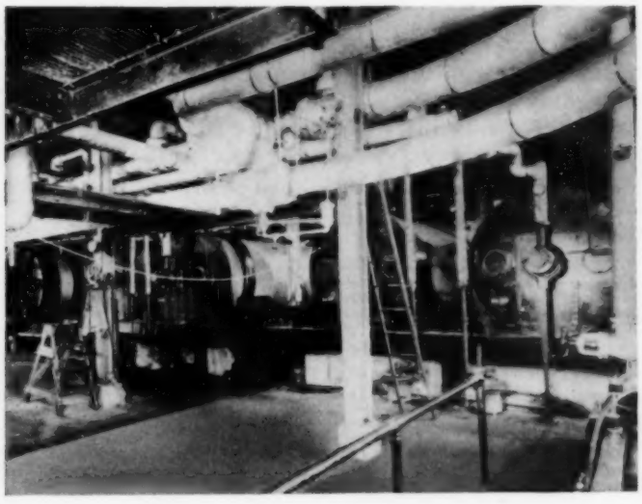


**Fig. 7—Louisville slop dryers in plant of American Commercial Alcohol Co., Pekin, Ill.**



of the grain. Fig. 7 shows six slop dryers built by the Louisville Drying Machinery Co. for the Pekin, Ill., plant of the American Commercial Alcohol Co. These handle slop from 6,000 bu. of grain daily. The value of the dried feed is approximately $21 per ton from a corn mash and $18 per ton from a rye mash.

ALCOHOL produced in distilleries is not considered whiskey, except after it has been stored and aged for at least four years, which is the minimum time required by the United States Pharmacopia. Its alcoholic content must be from 44 to 52 per cent or 88 to 104 proof. As to the aging, the exact reason for improvement in whiskey by maturing in casks is by no means clearly understood. It is usually ascribed to oxidation and the formation of ethers in the oak casks, which have been charred on the insides.

During maturing the alcohol acquires a mellow taste and its volume in the cask decreases from year to year. The Government takes cognizance of this by allowing the following "soakages" per year.

**Distilling Beverages from Grain**

| Period of Absorption | Kind of cooperage: Plain | Charred |
|---|---|---|
| First year | 9 lb. | 13 lb. |
| Second year | 12½ lb. | 14 lb. |
| Third, fourth & fifth year | 13 lb. | 14 lb. |
| After fifth year | 14 lb. | 14 lb. |

The alcohol in oak barrels is stored in concrete or brick warehouses securely protected against theft. The average temperature maintained is 95 to 100 deg. F. and its humidity about 20 per cent.

In aging whiskey the manufacturer has to consider the cost of alcohol, oak barrels, loss of alcohol during storage, insurance, and also fuel for maintaining the proper temperature.

Anyone contemplating the erection of a distillery, must carefully consider the regulations issued by the United States Treasury Department. According to these regulations, the owners are compelled to adhere to very strict Government supervision. In Form 27a to be filled out by the owners, all the stockholders, their names and residences must be given; the name of the owner of the stills and other utensils, the kinds of stills and the cubic content of each; the mode of mashing and fermenting, the number of hours the distiller will ferment each tub of beer; the number of gallons of mash or beer which will represent a bushel of grain; and the kind of materials to be used.

It is highly important to employ only skilled help as according to the Government *"the true spirit producing capacity"* of a distillery is not limited to what the distiller may produce by following a particular course which he has marked but the amount which can be produced, using all the machinery and apparatus under competent and skillful management.

The government has already established a certain limit of efficiency under which no distiller is permitted to operate a distillery without being penalized. In case of a grain or molasses distiller, the first point the Government determines is whether the distiller has accounted for all the grain or molasses used, and the spirits produced by him during the month. The assessment is based upon a production capacity of 80 per cent of the calculated capacity. If, for instance, a plant on a production capacity basis is 6,000 gal. and it produced 5,000 gal. only, the distiller would be assessed upon 1,000 gal. as a deficiency.

Because of the maze of contradictory figures that have been issued in recent months, it is desirable to scrutinize carefully those at variance with the following facts: According to the Treasury Department the United States used and produced the following amounts of grain and alcohol in 1917:

| Grain Used (In bushels) | | Alcohol Produced (In tax gallons) | |
|---|---|---|---|
| Corn | 33,973,268 | Whiskey | 57,651,834 |
| Rye | 2,375,439 | Rum | 2,842,921 |
| Malt | 4,239,677 | Gin | 5,756,666 |
| Oats | 6,730 | Brandy | 8,251,097 |
| Wheat | 2,533 | | 74,502,518 |
| Other materials | 72,039 | Alcohol | 211,582,744 |
| | 40,669,686 | Total | 286,085,262 |

Assuming that the distillers obtained 4.8 pr. gal. of alcohol per bu. of grain, then the total which could be produced from this grain amounted to 195,214,493 pr. gal. or based upon a 300-day year, the grain consumption was 135,565 bu. and the alcohol production 650,715 pr. gal. daily.

Since 1917 conditions in the alcohol industry have changed considerably. While the number of manufacturers, through mergers, decreased considerably, the total capacity of surviving plants increased to such an extent that distilleries mashing molasses now produce on the average, over 20,000 pr. gal. daily. All indications are that the new distilleries will produce beverage alcohol on a much larger scale than was ever attempted prior to Prohibition. A few distilleries under construction at present will be able to process more than 50 per cent of all the grain mashed in 1917. Whether there will be a remunerative field for small distilleries depends entirely upon their adaptability to modern chemical engineering methods.

When the enforcement of Prohibition restricted the supply of whiskey, the public acquired a taste for gin, of which the consumption in 1917 was less than 6,000,000 gal. Whether the demand for gin will prevail is problematical. It is anticipated that the public will gradually return to the use of whiskey, of which the consumption ratio to gin prior to Prohibition was ten to one. Not all pre-war whiskey was aged over four years in plain or charred white oak barrels as is required by the law for bonded whiskey, but was "blended," "rectified," or "cut" by the addition of high-proof spirits, flavoring, colorings, and sufficient distilled water to reduce the alcohol content to 50 per cent or less.

**Table III—Denatured Alcohol Produced During the Fiscal Years 1910 to 1932**
(In Wine Gallons)

| Year | Denaturing Plants | —Denatured Alcohol Produced— Completely | Specially | Aggregate |
|---|---|---|---|---|
| 1910 | 12 | 3,076,924 | 3,002,102 | 6,079,026 |
| 1912 | 14 | 4,161,268 | 3,933,246 | 8,094,514 |
| 1914 | 25 | 5,213,129 | 5,191,846 | 10,404,975 |
| 1916 | 33 | 7,871,952 | 38,807,153 | 46,679,105 |
| 1918 | 49 | 10,328,454 | 39,834,561 | 50,163,015 |
| 1920 | 52 | 13,528,402 | 15,307,947 | 28,836,349 |
| 1922 | 77 | 16,193,523 | 17,152,224 | 33,345,747 |
| 1924 | 83 | 34,602,003 | 33,085,292 | 67,687,295 |
| 1926 | 97 | 65,881,442 | 39,494,443 | 105,375,886 |
| 1928 | 82 | 46,966,601 | 45,451,424 | 92,418,025 |
| 1930 | 67 | 58,141,740 | 47,645,796 | 105,787,536 |
| 1932 | 49 | 34,298,235 | 44,031,281 | 78,329,516 |

# Economic Aspects of Chemical Process Development

By CHAPLIN TYLER

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A VERY LARGE PROPORTION of inventions is worthless, at least in regards to commercial exploitation. But even the promising ideas have but little tangible value until they have passed stages of process development. The typical chemical process development is expensive. A brief "look" at a process, requiring one man for three months, would cost about $1,500, and a more complex investigation with four men for 12 months about $25,000. Development costs amounting to $100,000 or more are not infrequent.

The fundamental factors involved in process development include a study of the underlying chemical reactions, changes of state and energy, time factors, and yield factors. From these data a flowsheet is constructed, showing materials and energy at each step of the process. Design of equipment and selection of construction materials is the next step followed by plant layout. Of equal importance are economic factors such as cost of plant and production, price and market conditions, and return on investment.

Prior to, or early in development, production costs should be roughed out, with successive refinements as the development progresses. The flowsheet is an excellent guide for rough estimates. Raw material costs can be set up, first assuming theoretical yields with pure materials, subsequently substituting the proper yield factors based on technically pure materials. Sufficient raw materials of desired specifications must be available. Here it is well to examine the depth of supply and the price history; also if any raw material is imported and thus subject to fluctuating foreign exchange, embargo or other governmental control. Water supply and miscellaneous factory supplies must also be considered.

Energy requirements must be set up, including electric power for all purposes, and fuel and steam for process use and heating. In planning metallurgical, electrochemical, and electrothermal processes particular pains should be taken to estimate energy requirements as precisely as possible for every step of the process. Power for refrigeration is a factor in some processes.

Direct labor for process, and indirect labor for repairs and maintenance as well as repair materials are usually important items. Provisions must also be made for supervision and factory overhead, sometimes 30 per cent or more of direct labor cost. Depreciation, taxes, and insurance; generally about 10 per cent of the investment per year; must be included in factory cost.

The foregoing items are factory costs, to which must be added cost of selling and administration, which vary much, but generally will run not less than 10 per cent of factory cost, excluding outward freight on the product. Freight, sometimes a large item, usually averages not less than $5 to $10 per gross ton according to quantities and distance shipped, freight classification, and type of container. Finally, credits may be included for byproducts, or debits for properly disposed waste materials.

Cost of plant can be determined roughly by analysis of manufacturers' equipment estimates or by reference to estimating engineers. Cost must also include site and improvements such as sewer, water, power, rail siding, and roads; buildings, and usually a steam plant. A generous percentage must be added for contingencies, engineering design, and contractor's profit. Cost of plant, conveniently expressed as dollars per ton-year of product varies from $10-$20 on very large bulk operations, such as superphosphate manufacture, to as high as $100-$200 on equally large operations, but with a different underlying technique, that is, requiring high temperatures and pressures, and nearly automatic control.

The total existing market for a product is roughly the domestic production plus imports, minus exports, with correction for stocks. However, this figure includes the entire country, and almost never represents the market actually available; the real task is to ascertain what really is available. First of all, a freight rate study will disclose the economic shipping area. Next, a territorial analysis of consumption by districts should be made, which, together with the freight study will reveal the maximum economic market. If possible, an independent analysis should be made, showing individual consumers, by name, by point of consumption, and by quantities consumed. It is also valuable to make an analysis of present supply, with names, location, and quantities supplied by various producers or importers. With these data in hand, a rational estimate may be made of (1) certain sales, (2) probable sales, (3) maximum sales. Without such data, the best that can be done is to assume arbitrarily that a fixed share, say 10, 20, or 30 per cent of the total market can be secured, a dangerous method, as factors unknown may shut off certain outlets.

### Rate of Investment Return

When the proposed output is very small in relation to existing consumption the price situation is not likely to be disturbed by new production. However, if the product is to displace other products, sales can be achieved only by virtue of lower price, higher quality, superior service, or some combination of these factors. Estimates should be made of competitors' costs and of the probable increase in demand market at various reduced price levels.

Rate of investment return, the ultimate test of any process is obtained by subtracting unit cost of sales from price, multiplying by quantity and dividing by investment. Generally, if the rate is less than 20 per cent, the process is not attractive. This may seem high, particularly as existing chemical companies rarely earn more than 10 per cent on their invested capital. Considering lean years and the inevitable tendency of estimators to be over-optimistic a requirement of an indicated 20 per cent return is not too severe. In fact, an indicated return of 30 or 40 per cent is much more comforting.

Presented before the students, course of the Fourteenth Exposition of Chemical Industries, Dec. 8, 1933.

# CHEMICAL ENGINEERING'S ROLE IN

By WILLIAM FELTON BARRETT
*Vice-President, Union Carbide & Carbon Corp.*
*Chairman, Carbide & Carbon Chemicals Corp.*

INDIVIDUAL RESEARCH and engineering is being properly and repeatedly recognized by the conferring of individual awards, medals and honorary degrees. In fact such recognition has been so frequent and has been publicized to such a degree, that the investor, the public and the youth of the country have perhaps been misled into believing that whole industries emerge in full bloom from the test-tube work of the secluded scientist. With no desire to deprecate the achievement of the individual it may be hoped that such awards as this one for group achievement may tend to correct this fallacy.

Commercial research, as distinguished from academic research, to be successful must, from its inception, be directed toward ends justified by economics. Problems must be constantly checked and evaluated, as they progress, by the economic yardstick. The chemical engineer, as differentiated from the chemist, must enter the picture and present his judgment as to many of the factors involved. It is sometimes as important to abandon an unprofitable research problem as it is to encourage and assist one of promise. In most cases it requires much courage.

In the direction of evaluation and commercialization of such scientific work of the chemist, the views of the engineer, the salesman, the patent counsel and the financial man are all of varying but unquestioned value. Each is the needed complement of the others. They are the five digits that make the hand a perfect mechanism —that give it power and skill and accomplishment.

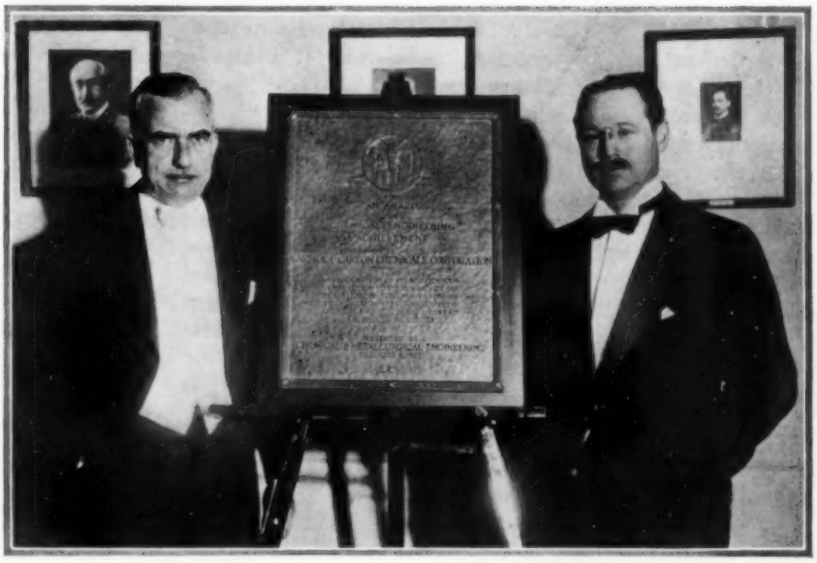
In the case of the Chemicals Corporation we pay full tribute to the essential and economic importance of our original research along organic chemical lines, coupled with our physical-chemical developments in the separation of mixed gases into their pure state. At the same time we recognize that the translation of these research results into an industry of magnitude, especially in the relatively few years of its existence, could not have been possible without the many and varied resources of our parent company to draw upon.

Perhaps a few specific instances of this coordination of resources may be of interest. In our chemical processes, most of which are new, it is necessary to pioneer, not alone in the products to be created but also in the design of equipment and the selection of materials. In many cases reactions are carried on at excessively high pressures or high temperatures, or both—possible only in special alloy steel equipment, which alloys are the results of research and experience of our Electro Metallurgical Co. That company and in some cases the carbon products division of our National Carbon Co. are employed to assist in the solution of corrosion problems. Special oxy-acetylene welding technique is often required in fabrication of equipment and this knowledge is provided by the engineers of our Linde Air Products Co. That company is also called upon for specialized information regarding fractionation and rectification, especially in the low-temperature field. It will be remembered that the Linde Co., in addition to being the largest manufacturer of oxygen in the world, adapted and developed its processes so as to achieve, commercially, the separation from natural gas of helium, theretofore a laboratory curiosity, and was the only producer during the World War. It will be appreciated that this source of engineering assistance is of the highest value.

While the foregoing may tend to minimize the romance associated with the Magic of Chemistry, they point out some of the conditions which have enabled us to have judiciously invested many millions of dollars in the development of an industry which has resulted in most satisfactory sales volumes and net profits.

These facts also seem convincing in support of the decision of *Chemical & Metallurgical Engineering* to recognize the force of group effort and attainment as a prime element in the advance of industry. But its editors go further and state that the award is also "in recognition of a broader participation by the chemical engineer in the affairs of the process industries." The term "chemical engineer" may be defined in an extremely broad sense or again may be defined in terms of the various courses leading to a Ch.E. degree in our universities. In the belief that *Chem. & Met.* uses the term in the broader meaning,—from that angle it may be pertinent to state that every officer of the Chemicals Corporation and every major department head is, or started his career as, a technical man with one or more degrees. It may be of interest to know that the Chemicals Corporation employs about 200 men holding tech-

# GROUP ACHIEVEMENT



*EDITOR'S NOTE: Chem. & Met.'s first award for chemical engineering achievement was made to the Carbide & Carbon Chemicals Corp. at a dinner at the Chemists' Club in New York, Dec. 8, 1933. In attendance were seven of the nine members of the Committee of Award and a group of twenty executives and engineers of the Union Carbide & Carbon Corp. Following an outline by the editor of Chem. & Met. of the purposes for which the award was established, and a statement by Chairman John Van Nostrand Dorr, of the Committee's procedure in selecting the winner, Malcolm Muir, president of the McGraw-Hill Publishing Company, Inc., presented the bronze plaque to William Felton Barrett. Extracts from the latter's address of acceptance are published herewith.*

nical degrees. Of these men approximately one-third are employed in research and development—one-third in engineering and operating and one-third in sales activities and executive capacities.

A significant side light on the management factor of an organization of so many technicians is the fact that since the company's inception, the "turn over" in our technical personnel has been practically nil. Unlike many corporations during the depression period, no technical men were discharged nor were our research and development programs curtailed. It is this fact which has insured no cessation of our fixed policy of yearly introducing new products.

In building our organization, we have attempted to use the greatest care in selecting our young technical men and, although selections are generally made with specific duties in mind, all new men are first given a period of work as cadet engineers. In this period an attempt is made to determine the specific adaptability of each individual, and he is then assigned to a department in which it is felt he will be able to work most efficiently. It has not always been possible in the first or second assignment to find the environment best suited to the individual, but we have been singularly fortunate in ultimately placing most of these young men in types of work in which their inherent abilities have been given an opportunity to grow and develop. Through this method of placing our technical men, there has resulted a wide dispersal of the chemical engineer into all of the various phases of our activities, not only in engineering and operation, but also in research, development, sales, and management as well.

While the usual development of a new process and its products proceeds in the order of research, development, engineering, construction, manufacturing and sales, the relation of these different phases of our activity in our chain of operation is such that valuable contributions are frequently made to one department by workers in another department far removed. Thus, the research and development units are linked to the sales department in certain phases of their work, the research department sometimes has workers in the manufacturing operations, and at times the development engineer finds himself progressively engaged in phases of the engineering, design and construction of the process he has developed. Ultimately he may find himself in charge of the operation of that process.

This form of organization, as encouraged and developed, has given the chemical engineer a degree of freedom of action which does not constrain his effort nor limit his ambitions. It has been the means of affording him that broader participation that is essential in developing men, new processes and products.

# Materials of Construction Trends

By LINCOLN T. WORK
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IN ANY CONSIDERATION of materials of construction for the chemical industries, it must be recognized that ordinary materials such as wood, brick, concrete, steel, bitumen, and copper are the most commonly used. The reactions of certain chemicals upon these materials have caused a number of construction materials to be developed which have special values under specific extreme conditions. These resistant materials should be considered in their places in the broad scope of the field, as may be seen by reference to the appended classifications of materials and properties. The present treatment of the subject emphasizes the materials on view at the exposition, but it is not restricted to materials for chemical resistance alone. Even the decorative materials are also noted. Both the newer materials and new developments in the older materials are stressed.

A number of recent trends were to be observed in the exhibits. Among the metals there were: the applications of the comparatively rare metals, platinum, tantalum, and magnesium; improvements in formulation and fabrication of stainless steel; and alloys for use with hydrochloric acid. Economy requires that a minimum amount of expensive metals be used in chemical equipment; and, while chemically resistant, such amount may not be adequately strong. Electroplating is one way to secure a thin protective coating of which chromium is an outstanding example. In many cases the layers which can be deposited economically by electroplating are far too thin to stand chemical or abrasive action in the service required. The use of sheet metal, backed by strong but non-resistant support, is well known, an example of which is lead lining. Newer trends indicate that the inner lining should be rigidly attached to its backing and thus the two materials would be handled and fabricated as one. Lead-coated steel, stainless-clad steel, and platinum-clad nickel are examples of this. Welding methods have been perfected particularly for stainless-clad steel to give ease in fabrication and not to impair the chemical resistance.

### Resins and Plastics

Among the non-metals the large number of plastics on display was outstanding. With the expiration of basic patents on phenol-formaldehyde condensation products several producers have entered this field. New resins are also being compounded and there is keen competition. Cellulose acetate and nitrate, alkyd and vinylite resins and urea condensation products are all finding uses which depend upon chemical resistance, insulating power, plastic character, beauty, and other special qualities. Laminated wood and impervious textiles are some of the newer applications of such resins. There are many other new or improved products which may be noted in brief.

In the inorganic, non-metallic field clay products such as chemical stoneware are being molded to yield thinner and denser parts which possess good strength, heat-shock resistance, and chemical resistance. Enamel linings are being made thinner to give better heat transfer and less tendency to chip. One manufacturer offers interchangeable parts which may be returned for new enamel coating when damaged, and the cost of this is about 40 per cent of the cost of a new piece. Patching material is offered for minor repairs. Pyrex glass equipment is offered in larger and heavier sizes. One application is the window for tin cans. As this glass will stand some heat and strain it can be used under the conditions of fabrication required for this work. Glass columns of 24 in. diameter are now available. Bricks are another form in which glass is offered.

Molded products of cement or lime are finding new uses. One product is made of lime and shale, and it is claimed that reaction between lime and the siliceous material gives it special strength. Asbestos and cement products are offered in the form of pipe, and as wall partitions. The protective and decorative coating of aluminum by anodic oxidation is a comparatively new development. Carbon is being fabricated into such forms as electrical precipitator tubes and raschig rings.

### Stainless Steels

Among the metals the 18-8 chrome-nickel stainless steel is stabilized against the action of heat during welding by the use of titanium in a fixed ratio to the carbon. Duriron has been modified by addition of molybdenum to resist hydrochloric acid. Alloys of iron with nickel, chromium, and molybdenum have been developed for hydrochloric, phosphoric, acetic, and other troublesome acids. Nickel is finding increasing application in caustic evaporators and nickel-clad iron is offered for the same purpose. An alloy of nickel with chromium and iron is prepared for heat resistance. Aluminum foil is built up in layers separated by air spaces to give a light weight heat insulator. Since platinum reached a low price but little over the present price of gold, it may find more extended application. Heavy chromium plate shown on a roll dryer gives a smooth and resistant surface.

Among the organic products, rubber coated steel is finding new applications. A soft layer is attached to the metal to take care of expansion stresses, then there is a hard layer, and finally a soft layer to resist abrasion. One producer of plastics uses asbestos with phenol-formaldehyde resin for chemical plant equipment. Laminated wood with plastic binder was shown at several booths. In one case asbestos paper is used in the laminations, and it is said to resist the action of fire. Practically all of the resins are fabricated into products of beauty and these exhibits represented a very colorful part of the exposition. Perhaps the phenolic formaldehyde-asbestos equipment which has only recently been introduced in America offers most interest to the chemical engineer.

Thus the exposition revealed a trend in materials of construction toward more extended use of the less common materials and toward greater economy through the use of coatings and through simplicity in fabrication.

Presented before the students' course of the Fourteenth Exposition of Chemical Industries, Dec. 8, 1933.

# Principles of Chemical Engineering Discussed at Roanoke

EDITORIAL STAFF REPORT

THE twenty-sixth annual meeting of the American Institute of Chemical Engineers was held in Roanoke, Va., Dec. 12-14. The technical programs included papers on a variety of subjects. Principles of chemical engineering featured one of the sessions.

At the session on "principles of chemical engineering" held concurrently with one of the technical sessions of the Institute on Dec. 13 five papers on condensation and evaporation were presented. The first paper, the isothermal flow of liquid layers by Cooper, Drew and McAdams, presented data on the film thickness of fluid layers flowing under the action of gravity, which are required in equations for predicting the resistance of the condensate film, and it was pointed out that there is a definite transition from viscous to turbulent flow corresponding to that found for flow in pipes.

A paper on heat transfer by condensing vapor on vertical tubes by C. G. Kirkbride contained additional data on the same subject by a different experimental method and attempts to correlate condensation coefficients with the equations derived for the flow of the vertical layers. G. M. Hebbard and W. L. Badger offered a paper on steam film heat transfer coefficients for vertical tubes in which experimental coefficients obtained on a long vertical tube were shown to run somewhat higher than called for by the theoretical equations.

In a paper on the drop-wise condensation of steam, W. M. Nagle and T. B. Drew presented a comprehensive discussion of this subject and pointed out that over-all heat transfer coefficients for condensing steam can be markedly increased under certain well-defined conditions which promote drop-wise condensation instead of the formation of a uniform film. The paper on evaporation was a study of entrainment in a forced circulation evaporator. Measurements of the liquid carried over by the vapor from an experimental evaporator were interpreted in terms of the liquor and gas velocities.

Wyman P. Fiske of M.I.T. opened the first technical session with a discussion of the timely subject of amortization, depreciation, obsolescence and replacement. He stated that much textual and periodical material is available on various aspects of equipment policy. A considerable part of the material that has previously been presented has been written in technical terms for the professionally trained accountant and is therefore confusing to men without accounting training. It was the object of this paper to restate the basic concepts and relationships involved in the replacement aspects of equipment policy and to state the fundamentals of a sound approach to the economics of choice between alternative equipments or processes. In passing, some of the common mistakes and fallacies were pointed out. Dr. Fiske did not attempt to bring forth any startling new principles, but rather to make a clearer statement in simple non-technical terms of ideas that are old but often misunderstood or forgotten.

In discussing the subject of the development of air conditioning, P. L. Davidson, Philadelphia District Manager of the Carrier Engineering Corp., stated that, today, there are some 200 different industries which require partial or complete conditioning of the air for some or all of their manufacturing processes. The most important of these is the manufacture of cotton, silk and rayon textile yarns and fabrics.

The rayon industry in this country had its birth at a time when air conditioning was becoming an established art. It, therefore, grew up with the aid of air conditioning and did not adopt it as silk and cotton did, only after the complications of its size made it essential. As a matter of fact, without the control of temperature and humidity, it would have been impossible for the rayon industry to have grown at all.

The manufacture of asbestos, the ceramic industry, the production of capsules, the manufacture of Cellophane, chewing gum and photographic film, the baking of bread, the brewing of beer, the ripening and storage of bananas, the manufacture of such breakfast foods as Postum, the packing of coffee, the milling of flour, the manufacture of sausage, the growing of mushrooms, the manufacture of matches, the packing of effervescent salts and the manufacture of rope are a few of the industries which have found air conditioning an essential aid.

The many changes occurring within the human body under conditions which prevent the usual loss of surplus body heat signify the necessity for controlling unfavorable temperature conditions wherever human beings must live. These disturbances of the body functions, even when slight, exert a marked effect on human efficiency.

According to new researches, the maximum amount of work was performed between the effective temperature limits of 40 and 75 deg. Subjects of the experiments were capable of performing four times more work in a temperature of 100 deg. with a relative humidity of 30 per cent than they could in a saturated condition of 100 deg. With the ordinary summer humidity of 60 per cent, the subjects performed about five times more work in a temperature of 90 deg. than in one of 120 deg. There is a beneficial effect of air movement when the effective temperature of the environment is below the temperature of the body; above body temperature, air movement adds to the discomfort.

From investigations made by the Industrial Fatigue Research Board in the coal mines of England, it was found that the rate of production decreased from 100 per cent at 65 deg. effective temperature to 59 per cent at 81 deg. effective temperature, and the accidents increased from 78 to 137.

The Eastman Kodak Co. conducted experiments on ventilation and a comparison of records for a year of good and a year of bad ventilation showed a 4 per cent increase in output and a 50 per cent decrease in illness in the ventilated plant.

Davidson predicted, "The buildings erected today and tomorrow without air-conditioning will be obsolete in five years. Air-conditioning is sound from every angle from which it can be analyzed, and it will soon be incorporated in every building and residence of any importance."

Paul Bancel, of Ingersoll-Rand Co., in a paper on water vapor refrigeration, discussed the use of both the steam jet and the centrifugal compressor as boosters in the production of cooled water in the range from 45 to 55 deg. F. As he pointed out, the idea of water vapor refrigeration is not new, having been, in fact, the first refrigeration cycle considered. Prior to the introduction of steam jet boosters for this purpose, the drawback to the method which had prevented its use was the relatively enormous volume of vapor to be handled, making reciprocating compression out of the question.

### Steam Jet Refrigeration

Steam jet refrigeration has become increasingly important in recent years and is now fairly well understood by most engineers. It depends on the use of a steam jet compressor placed between an evaporator and a water-cooled condenser so that the water vapor given off at high vacuum can be compressed to a pressure corresponding to the available cooling water temperature. Cooling of the water in the evaporator follows from the abstraction of the heat necessary to effect evaporation. The method has two important operating characteristics: First, it has an inherently large reserve tonnage capacity, increases in demand being accompanied by only a small increase in cooled water temperature. And second, the equipment must be provided with a reserve of 25-50 lb. steam pressure to take care of the contingency of warmer condenser water than that for which the unit has been designed.

Compression of the water vapor by mechanical means has heretofore been considered an economical impossibility. Bancel's company, however, attacked the problem through the centrifugal compressor with the result that a design was perfected which is able to compete favorably, within its operating temperature range, with other refrigeration cycles. The condenser load is obviously much smaller than that required with the steam jet booster, an advantage where the cooling water supply is restricted. Furthermore, it is an inherent feature of this device that the power consumption at part load is almost directly proportional to the load, a characteristic that is not shared by any other refrigeration cycle. Like the steam jet machine, the centrifugal unit shows only a small increase in chilled water temperature under overload conditions. Such units are now being built in standard sizes ranging from 50 to 350 tons capacity, employing compressor speeds of 7,000 to 10,000 r.p.m.

### Utilization of Coal

The very considerable increase in the efficiency of utilization of coal by industry within the past two decades may be attributed primarily to advance in methods of handling materials and controlling operations, to the improvement of auxiliary equipment—such as the steam turbine in power generation—and to the development of materials capable of withstanding higher temperatures and pressures, according to H. H. Lowry, director of the Coal Research Laboratory, Carnegie Institute of Technology, Pittsburgh. During this period of rapid growth in the engineering aspects of coal utilization, knowledge has been accumulating steadily regarding the chemical nature of coal. It must be recognized that in order to yield the desired result in any field of utilization, coal must undergo a series of chemical reaction, and that, therefore, the chemical aspects of the use of coal as a raw material must continue to assume increasing importance as the mechanical equipment associated with its use approaches perfection. To get the most from coal, as well as the most for coal, the coal technologist and the coal producer must have a more thorough understanding of the chemical reactions involved in combustion, coking, gasification, and hydrogenation processes and as complete a knowledge as possible of the chemical nature of the coal used. Much fundamental scientific study needs to be given to each of these complex chemical processes.

Dr. Lowry gave a brief review of the chemical nature of coal, and certain chemical aspects of the utilization of coal for hydrogenation, coking, combustion and gasification were discussed.

In conclusion he stated:

"The present knowledge of the chemistry of coal utilization is extremely incomplete. Need for additional work on the fundamental chemistry of coal and its reactions is emphasized. The engineer has achieved much in coal utilization with the limited knowledge of the nature of coal itself at his disposal. Can we not look for still greater achievements as more is learned about our most important chemical raw material, coal?"

Several of the papers presented at the meeting appear at greater length on the following pages. The papers included are: A Printing Ink and the Method for Discharging From Paper, by Sidney D. Wells; Recent Developments in Nitrogen Fertilizers, by C. L. Burdick; and Acetic Acid Dehydration, by Donald F. Othmer.

# Dehydrating Aqueous Solutions of ACETIC ACID

By DONALD F. OTHMER
*Assistant Professor of Chemical Engineering*
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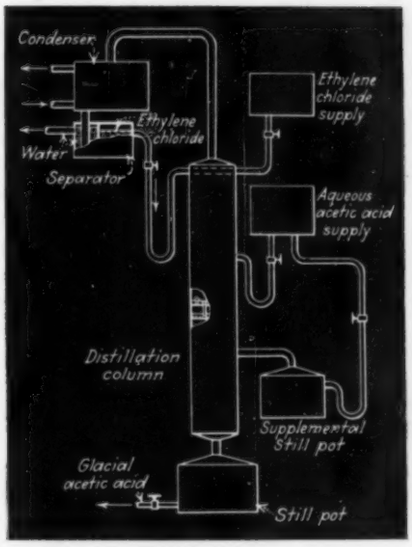



**Process of dehydrating aqueous acetic acid in which ethylene dichloride is employed as an entraining liquid for the water in the acid**

ACETIC ACID has always been the most abundant and most useful of the fatty acids. Like its other near homologues, it has a strong affinity for water; not so strong as that of formic perhaps, but sufficient to be of interest; and much technical skill has been expended in devising methods for overcoming this affinity. The anhydrous, or glacial acid has several important uses, one of which is manufacture of cellulose esters. Dehydration of aqueous solutions is important not only in the methods for producing the raw material, but also on account of the dilution which always occurs to the large quantity of cycled acid used in cellulose processing. The present purpose is to classify by types some of the methods proposed or in use for removing part or all of the water from acetic acid solutions. Only a few of the many processes available can be discussed; but the general theories will be compared.

The oldest process for production of anhydrous acetic acid involves neutralization with an alkali, evaporation, drying, decomposition of the acetate with sulphuric acid, and distillation of the acetic acid. Theoretically an anhydrous acid may be obtained in this manner, but in practice, when lime is used as alkali, a crude material averaging about 80 per cent is obtained, which subsequently is refined. Schaack and Calvert (U. S. Patent No. 1,765,-318) decompose the calcium acetate with sulphuric acid and filter off the gypsum formed, leaving a mixture of sulphuric and acetic acids which is suitable for certain purposes. An analogous process to the salt conversion is the esterification with methanol or ethanol, removal of water by distillation, and the subsequent hydrolysis and separation of the acid and alcohol (von Retze, U. S. P. No. 1,647,676, Lichtenthaeler, U. S. P. No. 1,660,756) forms the ester in the presence of hydrate forming salts which simultaneously absorb the water.

There are other chemical processes involving a neutralization or combination with various organic materials, Such as Othmer U. S. Patent No. 1,897,816 which combines acetic with triethanol amine in much the same general process as has been used for absorbing hydrogen sulphide and other weak acids from air. The water is first driven off by heat, and the acetic acid is then removed by decomposing the triethanol amine complex at a somewhat higher temperature. Dreyfus (U. S. P. No. 1,851,664) reduces the acetic acid to acetaldehyde, removes the water, and oxidizes the aldehyde to concentrated acid. Materials which absorb water as hydrates have been used for removing the water in a chemical compound, as well as others showing a preference for the acetic in acid salts which are readily decomposed (British Patent No. 281,827). The chemical methods merge into the physical ones, especially extraction, in such processes as Schwaebel and Schleicher (U. S. P. No. 1,766,404) in which an unstable salt of an organic base increases extractive efficiency. Included in such processes would also be the important one of producing acetic anhydride via sodium acetate and sulphur chloride, or processes starting with dilute acetic acid such as the one involving the ethylidene diacetate stage. In a cellulose acetate plant the acetic acid used as solvent or diluent is several times greater than the quantity of anhydride used for acetylation, and in the best practice all is finally discharged as a dilute acid of from 25-40 per cent concentration. It is apparent, therefore, that all of this dilute acetic acid cannot be converted to anhydride without causing an oversupply of the latter.

In general, these chemical methods are of minor importance except in the wood chemical plants which have not installed modern processes, and, as related to anhydride. The complications of equipment and handling, the comparatively poor yields, and the waste of chemicals used are the principal disadvantages, compared with the physical processes generally preferred.

The first section of a paper presented before the Roanoke meeting of the American Institute of Chemical Engineers, Dec. 14, 1933. The remaining section will appear in a later issue of *Chem. & Met.*

The operation most frequently used for separating two liquids is distillation, and in most cases, rectification. The theory and practice is fairly well understood for binary mixtures and is based on the vapor-composition curve, which defines the composition of vapors from a boiling mixture of given composition. Accompanying is a curve for acetic acid and water, the closeness of which to the 45 deg. line, indicating a small difference between vapor and liquid composition, illustrates the difficulty of separation by rectification. It is possible, however, to attain a fairly efficient fractionation; and the 28 per cent, 56 per cent and 65 per cent strengths of acetic acid on the market represent these fractions obtained in the refining of an anhydrous grade from the 80 per cent crude made by the lime-sulphuric method described. A distilling column turning out acid free water at the top and glacial acid at the bottom has probably never been operated, although this would be theoretically possible; and calculations show that the column would not have to be of prohibitive height if modern, efficient bubbling caps were used. The heat cost would be excessive, however, on account of the large reflux ratio required.

### Trick in Distillation Technique

The difference in boiling points, 118.5 deg. C for acetic acid and 100 deg. C for water, is no smaller than for other materials which are satisfactorily separated by rectification. The closeness of vapor and liquid compositions may be regarded as due to the affinity between water and an acid which produces mixtures of constant boiling point, and makes entirely "abnormal" the vapor pressures of mixtures of water and mineral acids, as well as formic and other strong organic acids.

Resort may therefore be made to a trick in distillation technique first described by Sidney Young some thirty years ago in the production of absolute alcohol. The theory is simpler for acetic acid and water than for alcohol and water and rests on the simple steam distillation principle which forms the basis for experiments in all courses of elementary physical chemistry.

### Withdrawing Agent Requirements

The vapor pressure of a mixture of two liquids which are substantially mutually insoluble is, at any temperature, about equal to the sum of the vapor pressures of the individual liquids. Thus, the boiling point, the temperature at which the vapor pressure equals the total pressure in the system, will be considerably lower than that of either of the liquids alone. This simple relationship does not hold for liquids which are miscible; therefore, if an organic liquid, miscible with anhydrous acetic acid but substantially insoluble in water, is added to aqueous acetic acid and the mixture distilled, water and the organic solvent tend to distill together at a lower temperature, while the vapor pressure of the acetic acid will not be affected in such a marked degree. Rectification is the successive and progressive distillation of liquids to remove the material of the higher vapor pressure or lower boiling point. A rectifying column will thus separate the water-solvent mixture from the acetic acid more easily than it would separate the water alone.

Several requirements for a liquid to be used as a withdrawing agent for removing water from acetic acid have been enumerated by Clarke and Othmer in U. S. P. No. 1,804,745:

1. It must not react with acetic acid, nor be decomposed, when boiled with the latter, into impurities which would contaminate the acid.
2. It must be available cheaply in large quantities.
3. It should boil at a lower temperature than acetic acid and thus be readily and completely separable from the latter by distillation.
4. It must form an azeotropic mixture with water vapor.
5. Its miscibility with water should be low.
6. It must cause the concentration of acetic acid in the watery layer of the distillate to be always lower than that of the aqueous acetic acid which is being concentrated,—such difference in the concentrations being as large as possible.
7. The latent heat of the solvent and the composition of its azeotropic mixture with water-vapor should be such that the amount of heat required for vaporizing a unit amount of water (in the azeotropic mixture) should be as low as possible.
8. The distribution ratio of acetic acid between water and said auxiliary liquid, or in other words, the ratio of acetic acid in the water to that in said liquid when the two liquids containing acetic acid are in contact (say in superimposed layers), should be low.

No mathematical or graphical method, comparable to the McCabe and Thiele method for analysis of the rectification of more common binary mixtures has been devised for predicting the performance of a column working with a withdrawing agent; and, in all probability no method of any general usefulness can be devised because some of the controlling factors are interrelated with the particular design of column employed.

In practice it has been found possible, while utilizing a withdrawing liquid, to operate a distilling column in much the usual manner, but with one condenser only at the top, which spills condensate into a gravity decanter. Advantage is taken of the difference in specific gravity between water and entraining liquid; and all of the latter, after separation in the decanter, is returned as reflux, the water being discharged substantially acid free. With such an arrangement, the reflux ratio is automatically fixed to the amount of entraining liquid brought over the head of the column for a given amount of water. Ricard and Guinot (U. S. P. No. 1,862,706) describes this method, but the method itself was in use by many others long before the date of this patent. Distillation using withdrawing liquids under several atmospheres pressure has been suggested (Keussler, Canadian Patent No. 268,241); but, from considerations which follow, this will be seen to offer no advantage in the usual case.

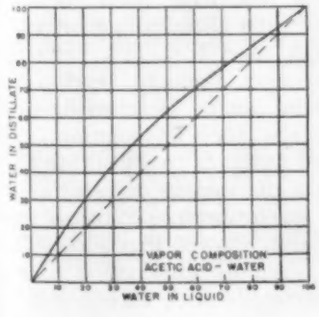
The thermal efficiency of such a process is largely dependent upon the relative vapor pressures of water and of the solvents employed. Thus, if isopropyl ether is considered, (Davidson and Schaefer, Can. P. No. 324,-125) the vapor pressure is so much higher than that of water that the proportion of water in the vapors is very small. From the curve and the molecular weights of isopropyl ether and water it may be calculated that only one gram of water will be carried over for 20.9 grams of isopropyl ether. Thus a distillation system using isopropyl ether as a withdrawing liquid will return ap-

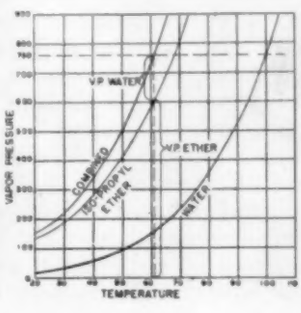
proximately 20.9 grams of isopropyl ether as reflux against one gram of water removed from the acetic acid. If the dilute acid was of 25 per cent strength, for example, this would be multiplied by three, giving 62.7 grams of isopropyl brought over the top per gram of acetic recovered.

With ethylene dichloride as a withdrawing agent as covered by U. S. P. No. 1,804,745, the method of adding vapor pressures, and converting from relative moles to relative weights, gives a ratio of approximately 11.9 grams of ethylene dichloride per gram of water. The important consideration is the amount of heat required for the separation; and if the weight of entraining liquid is multiplied by the respective latent heat it follows that 1,425 cal. are needed to vaporize the isopropyl ether required to bring over one gram of water, compared to 920 calories with ethylene chloride. Neither of these figures takes into account the heat required to bring over the one gram of water itself—which in both cases may be regarded as about 540 cal.

While this calculation shows that ethylene dichloride has much higher thermal efficiency than isopropyl ether in removing water from acetic acid, other materials have considerably greater efficiency in this regard. Of the numerous known which satisfy the requirements enumerated, all are subject to patents granted to a half-dozen inventors or assigners, or of patent applications controlled by the author personally; and several indicate the possibility of concentrating acetic acid more cheaply than by any method now in industrial use.

This discussion has included merely the removal of water by the distillation process, if the process is discontinuous the acid is finally completely dehydrated in the pot; it contains the withdrawing liquid which must be removed by further rectification in the usual manner as a separate fraction whereupon the acid is finally distilled over free from water and dehydrating agent. In the continuous operation, which is much to be preferred here, as in most other distillation methods, the column is simply charged with sufficient entraining liquid to accomplish the dehydration at the top, without getting into the pot, wherein is maintained anhydrous acetic acid. The lower section of the column is thus used in the usual operation of separating acetic from a lower boiling material—the entraining liquid. Dilute acid feed is introduced at some point on the side of the column; and the whole proceeds as a satisfactory machine separating substantially water free acid at the bottom and acid free water at the top. The only remaining factor to allow the process to proceed indefinitely is the fact that the water discharged from the decanter will be saturated with the entraining liquid and would ultimately remove all of it from the column. This is taken care of in one of two ways; (1) if its solubility in water is low and the material is cheap, the water is run to waste; and fresh withdrawing liquid is introduced into the column from time to time to balance the loss; (2) the water is run into the top of a second small distilling column which strips it of the withdrawing liquid and discharges the withdrawing liquid in substantially the same mixture with water vapor as that issued from the main column. This vapor mixture from the stripping column may then be passed to the same condenser as that from the dehydrating column, and the condensate is indistinguishably mixed in passing to the decanter.




Othmer (U. S. P. No. 1,917,391) illustrates the arrangement of equipment for the continuous dehydration of acetic acid using ethylene dichloride as a water removing agent, and details the controlling factors in the design and operation of such equipment. The relative arrangement of the pieces of equipment are illustrated in an accompanying diagram. A further modification described in this patent allows the preliminary separation of salts and other non-volatile waste material in dilute acid that is being recovered from such processes as the acetylation of cellulose. The dilute acid is pre-evaporated in the supplemental still pot corresponding to the "tube still" of petroleum distillation, and the mixture of water and acetic vapors is fed into the side of the column. Waste solid material remains behind in this pre-evaporator without entering the column. Salts of limited solubility in glacial acetic, if allowed to enter in a liquid feed, might suddenly precipitate out in the column at that plate where the last of the water is removed. Pre-evaporation removes the cause of this nuisance; and if the pre-evaporator is correctly designed, salts can be discharged from it without the need of shutting down any part of the system.

### Calculating Number of Plates

As mentioned above, no method for calculating and predicting the number of plates required in a distilling column for this separation has been developed; and different liquids, even of very nearly the same boiling point, exhibit widely different separating efficiencies in the same type of column and may even bring acid of a considerable strength over the head of the column. (The difference should be noted between "separating efficiency" which indicates the ease of separating substantially acid free water from substantially water free acid, and "thermal efficiency" indicating the amount of heat required to accomplish the separation). The last mentioned patent specifies 40 plates as a suitable number for the ethylene dichloride distillation referred to; and in general, depending on several physical properties of the liquid used, of which boiling is only one, the number of plates required for satisfactory separation may vary between about 15 and 60.

While this method of removing water from acetic acid by the aid of withdrawing agents is usually loosely referred to as azeotropic distillation, it is more nearly a steam distillation in the usual sense. A constant boiling mixture giving a distillate separating into two layers is termed a "heterogeneous azeotrope" and is quite different from the more usual homogeneous type ordinarily referred to simply as "azeotropic."

# De-Inking and Reprocessing Paper Accomplished by New Method

By SIDNEY D. WELLS

*Technical Advisor*
*Combined Locks Paper Co., Appleton, Wis.*

***THE use of dischargeable printing ink based upon a pigment consisting of the iron lake of haematein has now been continuous throughout a period of two years. The recovery of the groundwood paper printed with this ink has been taking place in large quantities throughout the past year. Telephone books in the larger cities from Omaha to New York and north of the Ohio River are now printed with this ink and the recovered directories are shipped to the Combined Locks Paper Co. In the manufacture of white printing paper, higher in quality than telephone directory paper, it is satisfactory to use large percentages of stock recovered from this process, in fact in some grades of printing paper as high as 80 per cent of such recovered stock can be used to replace a like quantity of virgin pulp. In consequence a new paper making material has been made available, which forms an important item in our national inventory of fibrous stock and the supply of such new material can be greatly increased should it become important to increase our national inventory of paper making stocks.***

▼

THE INCREASING DEMAND for paper making fiber has frequently directed the attention of paper makers to printed paper as a source of supply. Numerous processes for the liberation and removal of the carbon black pigment are known and some paper making plants have for a long time secured a large portion of their fibrous raw materials from paper stock recovered from discarded books, periodicals, and other publications printed on paper composed of cellulose fibers free from lignin.

There is a large quantity of paper of this character available, but a much larger tonnage of printed paper contains groundwood pulp, the fibers of which have not been chemically purified to remove the lignin constituent of the ligno-cellulose. Practically all of our newspapers and other publications, such as telephone directories, catalogs, agricultural publications and advertising circulars, use paper of this sort. Papers containing groundwood pulp are desirable, on account of their excellent printing qualities and opacity as compared with the higher-priced chemical pulp papers, for use where the permanency of record is not of importance but accurate presentation of the message is necessary and the weight and bulk of the publication is important as a matter of convenience and due to the cost of distribution.

Numerous attempts have been made to remove the ink from printed groundwood papers, but the recovered pulp fiber has not been sufficiently bright in color to permit its substitution for virgin stock. The difficulty encountered in the removal of printing ink from groundwood papers is caused by:

1. Detergents depending upon slight alkalinity to disperse the vehicle and varnish of printing inks have discolored the ligno-cellulose fibers or at least reduced the brightness of their color to a point below which they cannot be used in making paper which meets the standard requirements of brightness.

2. Bleaching agents such as calcium hypochlorite when used to bleach any discoloration, have been unsatisfactory because of the great demand of lignin for chlorine producing lignin chloride, which is deep brown in color.

3. The groundwood fibers contain such a large proportion of fine fibrous débris that the particles of carbon black used for the pigment of the ink are closely immeshed and can only be washed out by the copious use of water which invariably causes the loss of prohibitive quantities of fiber.

In view of the difficulties that have been encountered in the attempt to remove the chemically inert carbon black pigment universally used for black printing ink, numerous attempts have been made to develop an ink based upon a pigment that can be bleached or discharged and removed from the fiber by solution. A search made in 1928 revealed attempts to substitute for carbon pigment, black lakes of various dyestuffs or mineral pigments capable of resolution into colorless and soluble compounds. Such search showed that successful solution of the problem required the production of an ink which would compare favorably with carbon ink in

Based upon the paper, A Printing Ink and Method for Discharging From Paper, by Sidney D. Wells, presented before the Roanoke meeting of the American Institute of Chemical Engineers, Dec. 13, 1933.

printing halftones, covering power (mileage), color and wear on printing plates.

Before starting on the development of a dischargeable printing ink it was necessary to investigate the possibilities for using such ink in the field of publication that used a sufficient tonnage of paper to furnish an adequate supply of printed paper and which printed paper could be readily collected and assembled at a central point. The most ideal publication for the purpose proved to be telephone directories. Telephone companies in the larger cities issue new directories semi-annually and practically all companies make special efforts to collect all of the obsolete directories in order to avoid the loss of time and expense which is occasioned at central telephone exchanges when the public uses obsolete directories. The proportion of obsolete directories recovered by the telephone companies is high, and since such collection is in responsible hands, long-time contracts could be made for such raw material.

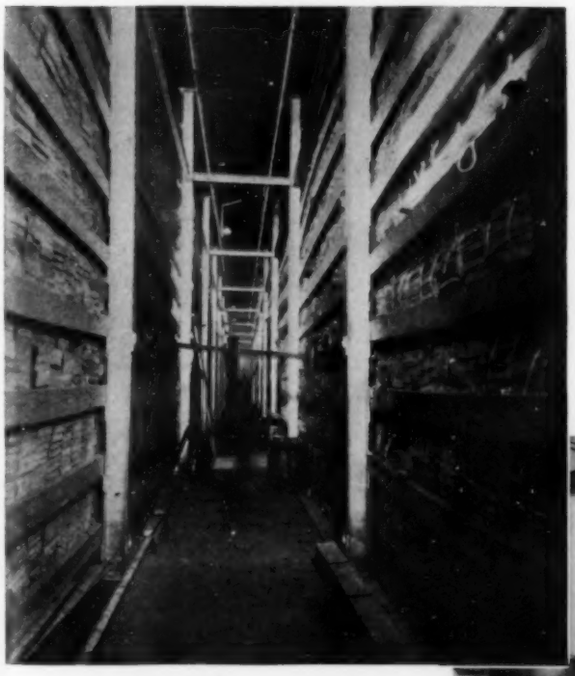
With the assurance that the supply of recovered telephone directories could be contracted for and that the proportion of directories printed with special ink which would be lost to the recovery process would be relatively small, the problem of developing a suitable ink was placed in the hands of printing ink specialists. The Hilton Davis Co. of Cincinnati, Ohio, developed a pigment composed of the iron lake of haematein. This was compounded into a printing ink that met all the requirements of the printer and publisher. It was capable of being either bleached with hypochlorite solutions or discharged with reducing agents such as sulphur dioxide in the presence of moisture, and the discharged product dissolved in dilute sulphurous acid.

The development of this ink depended upon knowledge of the principles involved, the problems of the printer, and long experience in and contact with the manufacture of printing inks and printing. While the cost of the ink in the development stage is more than that of the inks based upon carbon black which were used previously, the increase can be absorbed in the margin between the cost of the recovered stock and virgin stock.

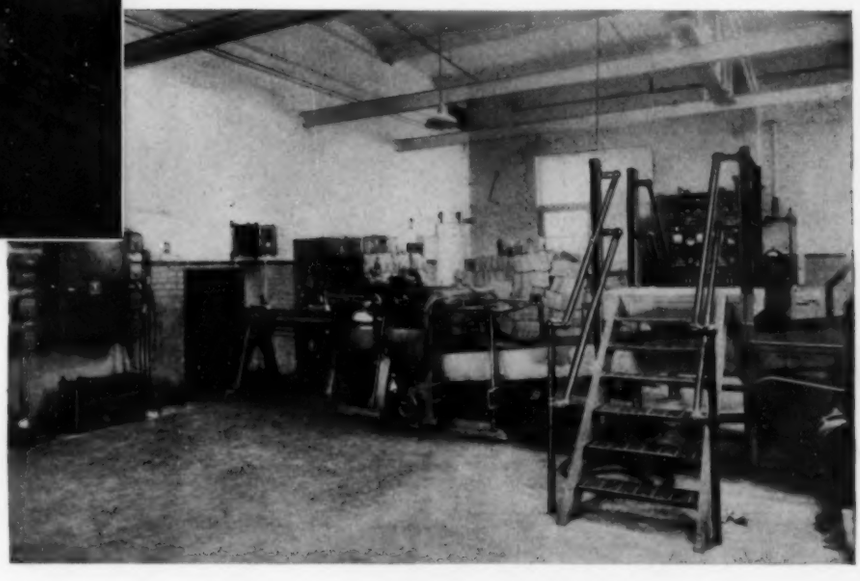
As soon as it was apparent that a satisfactory ink was available, the problem of developing a satisfactory paper recovery process was undertaken, first in the laboratory, then on a pilot plant scale, and finally in a plant having a productive capacity of over 60 tons of recovered stock per day.

The use of calcium hypochlorite as a bleaching agent was recognized as a possibility for the recovery of the paper stock. But the difficulty of using it on a stock containing groundwood seemed to make it undesirable from the standpoint of technical control and also because the quantities of reagent necessary indicated a manufacturing cost greater than considered permissible. It soon became evident that sulphur dioxide as a reducing agent would yield the most economical process available.

The first efforts to recover the paper stock printed with the new ink followed the common practice of working with pulp suspensions of about three per cent consistency. Treatment of such suspensions with sulphur dioxide gas sufficient to create a concentration of 5 grams per liter resulted in the discharge of the ink in about 12 hr. Increasing the concentration to 10 grams per liter reduced the time to about 3 hr. Use of solutions of this strength or greater would be extremely difficult and disagreeable in beaters, Belmer bleachers or similar open types of pulp mixing and circulating equipment. The washing of the pulp on rotary filters of standard construction would



**Storage for 4,000 tons of obsolete telephone directories permits continuous operation with periodic collection**



**Books are fed into the feeding conveyor and delivered to the back and cover remover, which handles various size books. This machine cuts off about three-eighths of an inch of the back, removes the covers and separates pages according to color**

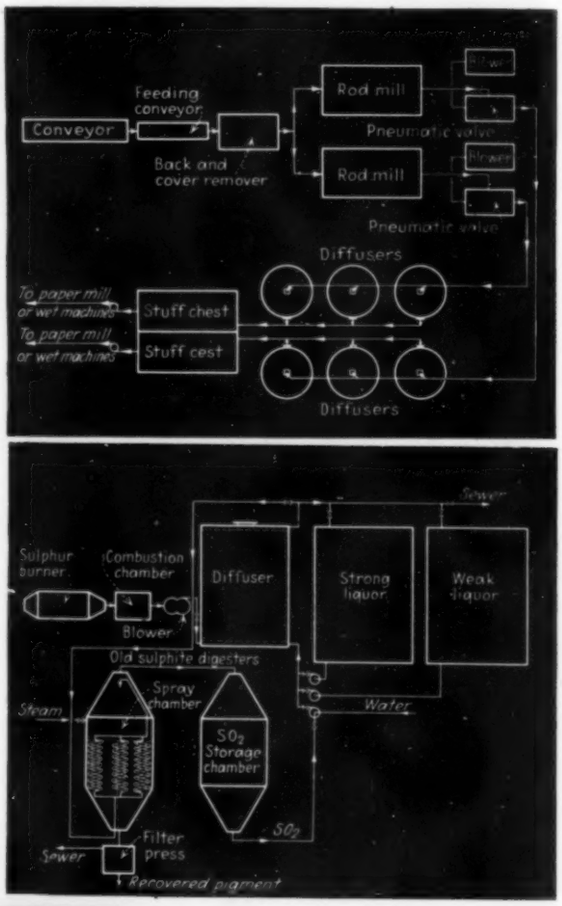
also create unbearable conditions for the operators. Actual mill trials confirmed these observations and made it necessary to investigate the possibility of treatment in closed vessels.

A revolving barrel type butter churn was next used with a hollow trunnion through which sulphur dioxide gas could be admitted as desired. The churn was two-thirds filled with macerated printed paper stock at a consistency of 20 per cent. Gas was admitted until a concentration of 50 grams per liter was attained. This concentration required 20 lb. of gas per 100 lb. of paper stock (dry weight). Under these conditions the ink was discharged in 20 min. After discharging water was added to bring the stock consistency to about 10 per cent and the mass pressed to a consistency of 25 per cent in a wine press. It was then mixed with water to a consistency of 10 per cent and pressed again. A repetition of this step produced a bright pulp entirely satisfactory for use in the manufacture of white papers. It was then found that the liquors removed from one batch were capable of removing ink from untreated stock. Diffusion washing seemed desirable if possible, and studies along this line were next undertaken in a trial diffuser 5 in. in diameter and 13 ft. high.

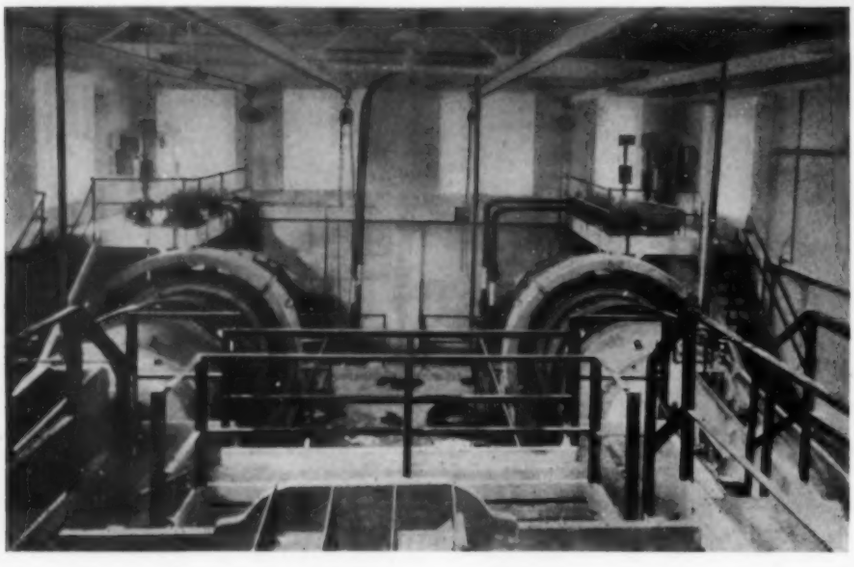
The diffusion studies soon made it clear that paper stock composed of groundwood and sulphite was entirely too impervious to water to permit a satisfactory rate of diffusion through a reasonable height of stock. The usual furnish as it passes onto a paper machine will have a freeness of between 115 and 135 as measured by the standard Canadian freeness tester. Sulphate pulps which are commonly washed by diffusion will show freeness tests from 600 to 700. The problem was to put a stock having a freeness below 135 into such form that it acted like a stock having a freeness above 600.

Earlier work indicated that when pulp is passed through a rod mill with about four parts of water to one part of dry fiber the stock passing through the outlet is in the form of little pellets or nodules, highly absorbent and of uniform density. The use of the 3 by 5 ft. rod mill at the Forest Products Laboratory was then secured and batches of printed telephone signatures treated. The consistency of 20 per cent was found to be best for the purpose. Freeness tests on nodulized telephone directory paper ran between 600 and 750.

The nodules obtained in these runs were then treated in the diffuser and it was found that satisfactory washing was possible, that countercurrent washing was satisfactory and economical and that the nodules could be treated with sulphur dioxide in the diffuser before the diffusion was commenced. It was also found that more rapid diffusion and less packing took place by passing the liquors from the bottom up through the stock rather




**Flowsheet for liquor use and recovery. At top flowsheet for paper stock**



**Separated pages are conveyed to different Marcy rod mills depending upon color of paper, and the necessary water is added to produce nodules of between 20 and 25 per cent consistency. Each mill will nodulize two tons of dry paper per hour with the expenditure of 90 hp.**

than from the top down as is more usually done when washing sulphate pulp.

The next step was to prove the feasibility of the diffusion principle on a larger scale. A pilot diffuser 3 ft. sq. and with a height between perforated false top and bottom of 13 ft. was provided. Several tons of printed paper were nodulized in one of the large rod mills at the Nekoosa Edwards Paper Co., Nekoosa, Wis., and shipped to Combined Locks, Wis., in a refrigerator car so as to maintain constant and uniform moisture. Several one ton batches were treated in the diffuser and the ink-free stock was run into white printing paper on a commercial paper machine. The paper obtained was printed on a commercial press.

The pilot operation indicated a sulphur dioxide consumption of 60 lb. per ton of stock and that no step in the cycle presented serious difficulties. On the basis of these tests our engineering department designed a plant capable of producing over 60 tons of recovered stock per day and the plant was constructed in the summer of 1931.

The progress of the paper stock during the process is shown in the accompanying flowsheet. The flow is divided into two lines after leaving the back-and-cover remover in order to handle white and colored paper separately. The white paper is passed through one line and the colored paper through the other. After removal of the ink the stock recovered from the colored paper is used again in the manufacture of colored papers.

### Treatment of Paper Stock

The books come from various cities in bundles and are stored in piles. They are fed into the feeding conveyor and delivered to the back and cover remover, which handles various size books. This machine cuts off about three-eighths of an inch of the back, removes the covers and separates the pages according to color. The pages are conveyed to different Marcy rod mills, depending upon color of paper and the necessary water is added to produce nodules of between 20 and 25 per cent consistency. Each mill will nodulize two tons of dry paper per hour with the expenditure of 90 hp. The nodulized stock drops into screw conveyors which deliver it to a Voith pneumatic conveying system which blows it through 3 in. pipes to the diffusers located in a building about 60 ft. away.

There are six diffusers which consist of large wooden stave tanks provided with false bottoms and tops made of perforated sheet metal about 8 in. from the wooden top and bottom of each tank. The false bottom is chromium-nickel ferrous alloy such as is used for sulphite blow pits and the false tops of closely perforated sheet bronze, No. 65, such as is used for centrifugal screens. The tops permit maximum discharge of diffusion liquor while the bottoms support the weight and permit the distribution of the gas, diffusion liquors and wash water. The diffusers are in two lines of three each and rest upon wood-lined, concrete chests, shaped like Belmer bleachers and provided with circulating pumps. Each diffuser and each chest holds approximately 15 tons of stock at different consistencies. On dumping from a diffuser to the chest below sufficient water is used to reduce the consistency to between four and five per cent. From the chests the stock is pumped to rotary filters where every trace of acid is removed. The stock is then either delivered to the paper mill or run into laps for storage.

While a diffuser is being filled with nodules gas from a rotary sulphur burner is blown into the bottom and is absorbed by the moisture in the nodules. Maintenance of the strength of diffusion liquors calls for the burning of 400 lb. of sulphur to each diffuser charge of about 15 tons of paper stock. On filling and closing each diffuser the gas connections are shut and strong liquor from earlier diffusions is pumped into the bottom until the diffuser is filled and the liquor passes out through the connections at the top of the weak liquor tank, strong liquor tank, or sewer depending on the sulphur dioxide content. The cycle for each diffuser takes 27 hr. The distribution of the liquor to and from each diffuser takes place as follows: To diffuser, 3 hrs. on strong liquor, 3 hr. on weak liquor, 21 hr. on water; and from diffuser, 3 hr. filling with liquor, 1 hr. to weak tank, 3 hr. to strong tank, 2 hr. to weak tank, 18 hr. to sewer.

### Treatment in Diffuser

The average test of liquor to the strong tank is 6 grams of $SO_2$ per liter and to the weak tank 4 grams of $SO_2$ per liter. Liquors testing below 2 grams of $SO_2$ per liter are discharged to the sewer.

While the plant is designed for a production of over 60 tons per day the decreased demands for stock during the past year have made it possible to continue the washing longer than is indicated in the schedule. The rate of flow through each diffuser is 60 gal. per min. Recent tests show that the addition of sulphur dioxide to the water, during the first 6 hr. a diffuser is on water, improves the operation.

Experiments show that the boiling off of sulphur dioxide from strong liquor leaving a diffuser will furnish a supply of sulphur dioxide undiluted with nitrogen. Two small abandoned sulphite digesters are being utilized to provide the recovery system shown in the accompanying flowsheet. The upper portion of one digester will act as a spray chamber for driving off the sulphur dioxide by means of steam while the lower portion will be provided with coils immersed in the descending liquor to absorb much of the heat contained therein by heating the incoming liquor passing through the coils on its way to the spray nozzle. The other digester will serve as a storage tank for sulphur dioxide so as to permit continuous operation and intermittent supply of gas. The pigment contained in the liquor is precipitated by release of the sulphur dioxide and by neutralization of any residual acidity with caustic soda.

### Distribution to and From Diffuser

With the operation of the recovery system the distribution to and from each diffuser will be as follows:

To diffuser, 3 hr. on strong liquor, 3 hr. on weak liquor, 6 hr. on sulphited water, 15 hr. on water; and from diffuser, 3 hr. filling, 1 hr. to weak tank, 6 hr. to recovery, 3 hr. to strong tank, 2 hr. to weak tank, 9 hr. to sewer.

While the liquors will be of approximately the same concentration in sulphur dioxide as at present they will contain less pigment in solution and remove the possibility of any slight discoloration of the pulp.

# Recent Developments in Nitrogen Fertilizers

By C. L. BURDICK
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SYNTHETIC ammonia as an industry is approaching the twentieth anniversary of its development. Early in this century fears regarding a prospective shortage of nitrogen were often expressed. For the last fifteen years the pressure has been steadily for cheaper nitrogen.

The figures in Table I disclose the pertinent facts regarding the present nitrogen situation in the United States. In addition to the 350,000 tons of inorganic nitrogen available for fertilizers, as given in Table I, about 50,000 tons in the form of organic materials, cottonseed meal, fish scrap, tankage, and others is used in the fertilizer market, making a total of 400,000 tons. Rate of consumption of fertilizer nitrogen in 1929 (a high average) was 365,000 tons, according to Brand[1]. The U. S. War Department's estimate for the military demand for fixed nitrogen for explosives for a first-class war would be not to exceed 150,000 tons per year. It is evident, therefore, that for either peace-time or war-time conditions the industry has to depend largely on agriculture for its markets, also that in a state of war the military requirements plus normal industrial demand would still leave large quantities available for fertilizer purposes.

Six years ago the ammonia department of the du Pont company began a survey of applications of nitrogen in fertilizer technology. In the past nitrogen has been an expensive fertilizer ingredient and there has been obvious need for cheaper, superior nitrogen materials. Advent of the method of treating superphosphate or mixed fertilizers with free ammonia gave promise of possibilities for a new technology based on cheap domestic synthetic ammonia.

Many possible nitrogen compounds and many methods of processing nitrogen with phosphoric acid and potash were studied. The general conclusion was that treatment of superphosphate with anhydrous ammonia should basically be the cheapest way of adding nitrogen to any fertilizer. Synthetic urea appeared to be the next in order and study of urea synthesis was accordingly undertaken. Manufacture of a combination urea-ammonia liquor (see *Chem. & Met.*, October, 1932, p. 540) for ammoniation of mixed fertilizer was begun about one and one-half years ago, and a wide manufacturing and agricultural experience has since been obtained.

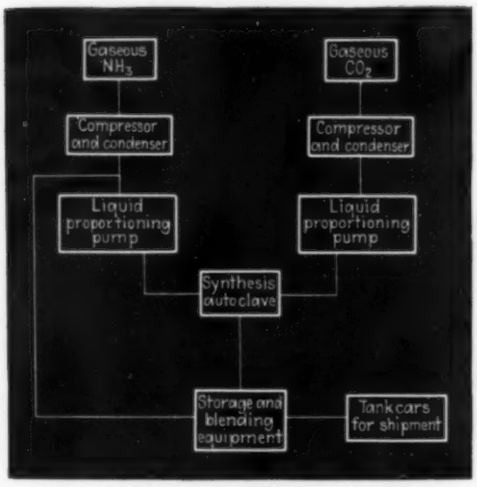


**Fig. 1. Diagrammatic flowsheet for synthesis of urea-ammonia liquor**

CRUDE UREA is one the oldest fertilizer materials; in the form of liquid manure, it has probably been employed since agriculture first began. Large scale advent of synthetic urea in Europe about thirteen years ago greatly stimulated experimental and practical work to evaluate the efficiency of urea compared with other standard nitrogen fertilizers. Much of the work in this country has been done by state agricultural experiment stations and the U. S. Department of Agriculture; the results show urea to be in every respect as satisfactory as any other available form of nitrogen.

Early attempts to manufacture urea in this country were not particularly successful. During the War, as an emergency measure, du Pont manufactured a small quantity from calcium cyanamid. For several years, however, practically all urea used domestically was of German origin, until in the summer of 1932 urea-ammonia liquor came on the market. As urea has always been sold at a much higher price per unit of ammonia than ammonium sulphate and sodium nitrate, its use in

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agriculture has been restricted, but it has found a constantly increasing use in this country.

The fundamental reaction representing the synthesis of urea is $2NH_3 + CO_2 = (NH_3)_2CO_2 = (NH_2)_2CO + H_2O$. These reactions do not go to completion in either direction. Krase, Gaddy, and Hetherington, of the U. S. Department of Agriculture, have carried out extensive and valuable researches on the urea equilibrium. Their earlier work disclosed the relatively unfavorable conditions of urea synthesis as conventionally carried out. In their experiments temperatures, pressures, and proportions between reactants were varied to a considerable degree.

With full appreciation of the predictable mass-action effects favoring urea conversion by increasing the temperature, pressure and proportion of ammonia in the reacting solution the du Pont group had as its goal high percentage conversions with high rate of reaction. From these fundamental data an efficient and economical continuous process has been developed.

The $NH_3$–$CO_2$–$H_2O$ system at high temperatures and pressures corrodes nearly every practical material of construction. As an example, some of our early experiments were conducted in sealed gold tubes inside an autoclave in which internal and external pressure on the gold tubing could be balanced. Development from this stage to a large successful plant was a major engineering achievement.

Early in the experimental work Dr. F. W. Parker found that the conditioning action of ammonia on superphosphate in the presence of urea, when the urea and ammonia are added as a single solution, gave quite surprising results. Mixed fertilizers treated with urea-ammonia liquor reached at once a remarkably good physical condition. In many instances this has entirely eliminated the curing or storage period at the factory. The achievement of a high efficiency in the synthesis of urea in the presence of excess ammonia, and the marketing of this solution substantially as it comes from the autoclaves, has probably been the major advance in nitrogen fertilizer technology since the advent of the ammonia treatment of superphosphate.

**Table I—Annual Production Capacity for Inorganic Nitrogen Compounds in the United States**

| | *Short Tons of Nitrogen* |
|---|---|
| Byproduct sulphate and byproduct ammonia | 190,000 |
| Synthetic ammonia plants | 300,000 |
| Total | 490,000 |
| Maximum requirement for any prospective industrial demand | 140,000 |
| Available for other than industrial uses (fertilizers) | 350,000 |

**Table II—Comparative Acidity Equivalents of Nitrogen Fertilizers**

| *Material* | *Per Cent $N_2$* | *Acidity Equivalent, Lb. $CaCO_3$ Per Unit (20 Lb.) $N_2$* |
|---|---|---|
| Cyanamid | 22.0 | |
| Sodium nitrate | 16.4 | Basic and corrective to acidity |
| Calcium nitrate | 15.0 | |
| Calnitro | 20.5 | |
| Organic fertilizers | .... | 15* |
| Anhydrous (or aqua) ammonia | 82.4 | 36 |
| Urea | 46.6 | 36 |
| Ammonium nitrate | 35.0 | 36 |
| Ammonium phosphate | 11.0 | 107 |
| Ammonium sulphate | 21.1 | 107 |

*Variable from 36 lb. to basic

ABOUT a year and a half ago a full size unit for synthetic urea-ammonia liquor was installed at our Belle, W. Va., plant. Since then this material has been turned out regularly for delivery in tank-car quantities. A diagrammatic flowsheet for the synthesis of the urea-ammonia liquor is shown in Fig. 1 and a photograph of one unit in Fig. 2.

The properties of urea-ammonia liquor are well standardized. Its vapor pressure is about $\frac{1}{4}$ to $\frac{1}{3}$ that of anhydrous ammonia at the same temperature. The percentage composition being marketed is as follows: Urea, 32.5; ammonia, 28.9; ammonium carbamate, 18.1; water, 20.5. This liquor carries 55.2 per cent of total ammonia or 45.5 per cent nitrogen; $\frac{2}{3}$ as free ammonia and $\frac{1}{3}$ as ammonia fixed as urea. The composition is such that even winter conditions present no danger of urea crystallization in transit or in storage. The liquor contains suitable inhibitors to prevent corrosion, and is handled throughout in standard steel tank cars and steel equipment.

Urea-ammonia liquor received in tank cars at a commercial fertilizer plant may be stored in regular anhydrous ammonia storage tanks or diluted and pumped to the aqua ammonia storage tanks; in many cases it is used directly from the cars. Quantities to be used vary in different plants. One example for a 4-8-4 fertilizer may, however, be given. In this about 100 lb. of urea-ammonia liquor, representing 2.75 units of ammonia, is used. This compares with a maximum of 100 lb. for aqua ammonia, or 30 lb. of anhydrous ammonia, both representing 1.5 units of ammonia. Practically speaking, an excess beyond this may cause undue reversion to tricalcium phosphate. These quantities of ammonia will not cause an increase of over 0.2 to 0.3 per cent in

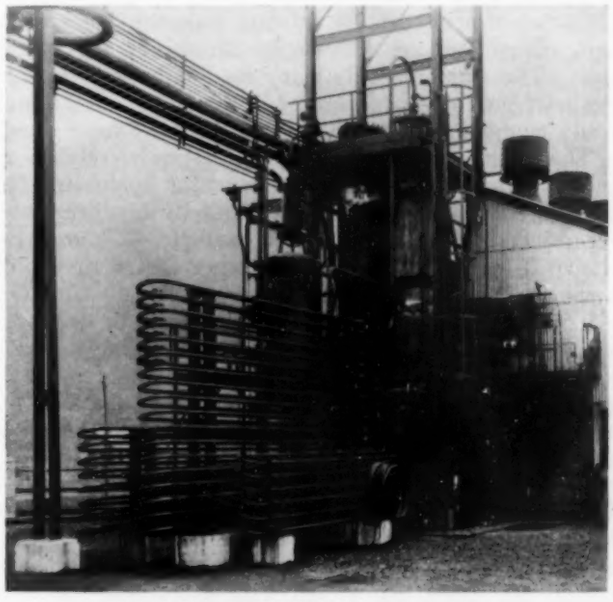

**Fig. 2. One unit of Belle, W. Va. plant for production of synthetic urea-ammonia liquor**

citrate insoluble phosphoric acid. It is thus seen that the use of urea-ammonia liquor permits the introduction of over 1½ times as much nitrogen in solution form as is possible with anhydrous ammonia for the same total reversion.

Hitherto prices for imported urea have been from 60 to 100 per cent higher than for ammonium sulphate, per unit of nitrogen. At the present time, with imported urea quoted at $90 per ton, or 8c. per lb. of ammonia, and ammonium sulphate at $24 per ton or 4.8c. per lb., the price per unit of nitrogen is 66 per cent higher for urea. Now, however, with domestic urea-ammonia solution in the same price range as ammonium sulphate, urea is for the first time available at no premium.

WE BELIEVE the best program for the American nitrogen producer is to continue to work in close association with the organized domestic manufacturers and distributors of mixed fertilizer. Future cost reductions in the manufacturing end of synthetic nitrogen products and of mixed fertilizers will probably be through minor technical refinements and organization of manufacture. The major economies will probably be effected in the distribution end by improvements in credit and banking practices.

It is my belief that the chief advances in fertilizer technology will come through increased suitability of our fertilizers to the soils. The concept N-P-K as the sole criterion for a mixed fertilizer is no longer sufficient. Other elements, such as sulphur, calcium, magnesium, and manganese, are established necessities for certain soils. These are not only being studied by experimental stations, but forward looking fertilizer companies are already compounding their products to meet these needs.

The next major advance should be in relation to acidity control of the soil and as a major influencing factor the control of potential acidities of fertilizer must receive detailed attention. For example, Tidmore[2] has shown in extensive field experiments the increased returns made possible by such control.

The acidity of a soil is readily corrected by appropriate treatment with limestone or dolomite and at the same time soil deficiencies of calcium or magnesium are remedied. Agricultural experimental stations have long advocated this, but the farmer has generally failed to follow, and in recent years the soils throughout the South and Southeast have become increasingly acid. With properly balanced fertilizers of neutral or of low potential acidity no extra treatment by the farmer will be necessary. If his soil is already very acid, it should be limed as a separate operation, but subsequent needs for lime would be met by the fertilizer.

Acidity of soils in the South and Southeast where heavy applications of mixed fertilizer have long been used has become an increasingly serious matter, directly affecting the fertility in many sections. The major causes of acidity are depletion of the soil bases by crops, selective leaching of the basic constituents, and, probably the most important, acidity occasioned by the use of acid forming fertilizers. All nitrogenous fertilizers now on the market, with the exception of sodium nitrate, calcium nitrate, and cyanamid are acid forming to a greater or lesser degree. Any form of organic or ammonia nitrogen applied to the soil is ultimately converted to nitrate, and unless adequate basic constituents are provided, a production of acid equivalent to the nitrogen added occurs. Of all fertilizer salts in current use, ammonium sulphate has the least favorable rating in regard to acidity. For each molecule nitrified, in addition to the two molecules of nitric acid thus formed, one molecule of sulphuric acid is produced from the $SO_4$ liberated by nitrification of the ammonium base. The sulphuric and nitric acids demand corresponding quantities of base from the soil, the reserve stock of which is thereby depleted. The explanation of the production of acidity by fertilizer ingredients applied to the soil has been most clearly set forth by Pierre[3]. Long time field tests confirm the theoretical viewpoint, and practice has established that 1.2 lb. of calcium carbonate is required per pound of ammonium sulphate, if the soil reaction is not ultimately to be adversely affected.

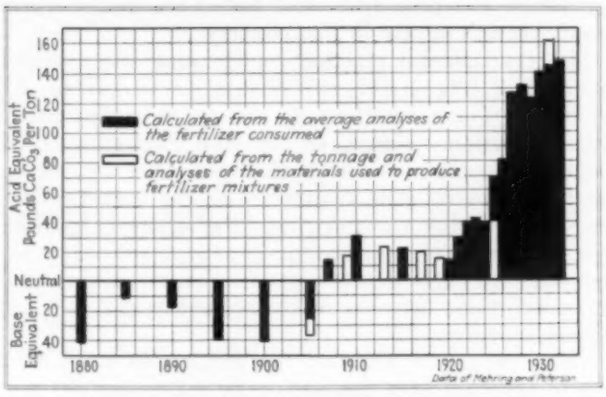


**Fig. 3. Average equivalent acidity or basicity of mixed fertilizers**

The actual rate of acidity production of the principal nitrogen fertilizers is given in Table II expressed in pounds of calcium carbonate required to neutralize the acid produced per unit of nitrogen contained. It is evident that the nitrogen compounds principally used for top dressings generally are basic in reaction, whereas the forms conventionally used in mixed fertilizers are acidic.

A wide interest in this subject of acidity is now awakened and not only experimental stations, but also the control officials and the fertilizer companies themselves, are taking cognizance of it. Pierre has recently carried his work further to include an analytical method for determination of the net ultimate acidity of any mixture of fertilizer materials[4]. With this tool in hand it should be only a question of time when this situation will be taken care of through proper formulation.

Mehring and Peterson's recent survey[5] of trends in fertilizer formulation over the last 30 years also brings out three important and striking facts. These are:

1. The $P_2O_5$ content of complete fertilizers has remained fairly constant since 1890, averaging about 9.4 per cent. Nitrogen and the potash, on the other hand, have increased 50 per cent and 100 per cent respectively during the same period, most of the increase coming during the last eight years. The complete fertilizer of today will average closely to a 3.5 per cent nitrogen, 9.6 per cent $P_2O_5$, 5.2 per cent $K_2O$ mixture.

2. Their data on the sources of nitrogen used in mixed fertilizers confirm that the equivalent acidity of fertilizers has increased rapidly in recent years. Ammonia and its salts constituted 2.1 per cent of the nitrogen in mixed fertilizers in 1900, 23.8 per cent in 1919, and 61.2 per cent in 1931. In the same years 91.0 per cent, 53.6 per cent, and 18.8 per cent of the nitro-

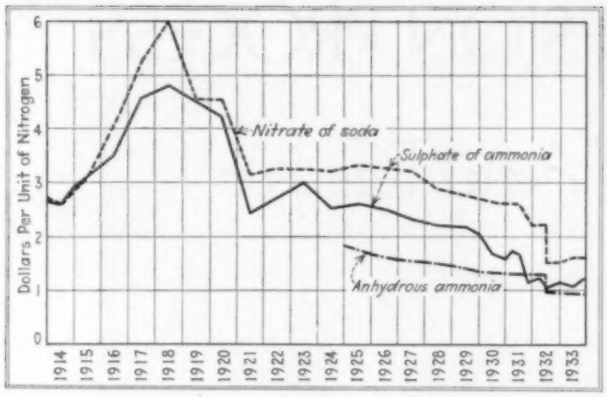


**Fig. 4. Average prices for inorganic synthetic nitrogen carriers in dollars per unit of nitrogen**

gen was derived from natural organics; and 6.9 per cent, 19.7 per cent, and 11.6 per cent from nitrate of soda.

In Fig. 3 are shown graphically values calculated by Mehring and Peterson[6] for the acidity (in limestone equivalents) of the average mixed fertilizer marketed in the United States from 1880 to the present time.

3. The filler content of fertilizers has increased from 6.8 per cent in 1900 to 12.3 per cent in 1925 and 15.2 per cent in 1931. This increase took place despite the fact that average content of total plant food increased from 14.1 per cent in 1900 to 17.9 per cent in 1931.

Calculation by Pierre's method for equivalent acidity of the present average grade of mixed fertilizer indicates that it requires an average of 160 lb. of calcium carbonate per ton to render it neutral in actual soil reaction and in several states the average is as high as 200 lb. Mehring and Peterson's data for inert filler now employed show there is ample margin in present fertilizer formulation to permit substitution of adequate limestone or dolomite for this acidity correction. MacIntire and his associates[7] have shown that limestone or dolomite can be used without loss of ammonia or reversion of $P_2O_5$.

Another factor receiving increasingly careful scrutiny is the relative efficiency and advantage of so-called "organic" nitrogen carriers versus "inorganic" nitrogen fertilizer materials. Some groups now advocate a classification on a "water soluble" and a "water insoluble" basis. This would place urea in the "water soluble" category, with fertilizers of animal or vegetable origin in the "insoluble nitrogen" category.

Organic forms of nitrogen have found wide popularity in the past, and as many of these have had alternative outlets for stock feeding purposes, they have commanded higher prices for fertilizer purposes than the corresponding inorganic carriers. My understanding is that modern agronomic data does not indicate these materials merit a premium classification, in fact, in many cases there is evidence that the water insoluble forms of nitrogen are less efficient than the water soluble forms.

Likewise, there is often a misunderstanding of the significance of the term "water solubility" and the supposed consequent liability of chemical forms of nitrogen to be leached from the soil. Nitrates leach readily from sandy soils during a wet season, whereas ammonia salts and derivatives, such as urea, are held so strongly absorbed or fixed by the humus and clay constituents of the soil that they are substantially unleachable; only as bacterial action accomplishes nitrification and oxidation is there any tendency toward leaching or washing away.

Recently wide interest has attached to work on ammoniated peat as a fertilizer material by Byers and by Davis, both of U. S. Department of Agriculture. Apparently a large part of the ammonia combining with peat at high temperature in an autoclave enters into chemical combination of the truly organic "water insoluble" category. The careful work now under way in numerous quarters, to evaluate the fertilizing value of this material, will afford pertinent evidence on the general merit of organic water insoluble forms of nitrogen.

THE preceding discussion of the problems facing nitrogen manufacturers and consumers indicates what we conceive to be the approaching advancements in the industry. In concluding, some further general aspects and trends are worthy of mention.

Prices of inorganic and synthetic nitrogen carriers are very nearly down to bed rock. The course of these prices since 1900 is shown in Fig. 4.

Ammonium sulphate now sells around $24, on port delivery basis. With proper allowances for manufacturing and distributing expense often no net credit whatever is obtained for the ammonia content of byproduct ammonium sulphate. Some factors favorably situated in the industry may perhaps net as much as 1c. or at the most 1.5c. per lb. of ammonia content.

The Chilean nitrate industry, in spite of great technical improvements, has been forced to undergo a drastic financial reorganization. Capital charges are apparently to be scaled down so that this industry will be able to set up a price structure which will represent out-of-pocket costs of production, delivery and sales, plus relatively very small fixed charges and moderate tax returns to the government.

In these past years of drastic price declines the synthetic nitrogen industry has shown no possibilities for even meagre earnings, and it is only by technical improvements and refinements and through steadily increased output that this industry has been able to hold its ground. Today I believe it can be said that no important reductions in operating or manufacturing expenses are to be expected for any of the principal nitrogen fertilizers. Further reductions in price may come through better organization and control in the distribution and banking and credit branches of the industry, but again it is my belief that the major prospects for progress are increased efficiency in the use of the fertilizers, and better understanding of their application in the field.

[1] "Recent Developments in the Fertilizer Industry," Charles J. Brand, *Int. Cong. on Agriculture* 1930.

[2] Tidmore and Williamson, "Experiments With Nitrogen Fertilizers and Limestone." Paper presented before the Fertilizer Section, A.C.S., Chicago, Sept., 1933.

[3] Pierre, W. H., "A Method for Determining the Acid or Base Forming Property of Fertilizers and the Production of Non-Acid Forming Fertilizers." *American Fertilizer*, Vol. 79, Oct., 1933.

[4] Pierre, W. H., "Determination of Equivalent Acidity and Basicity of Fertilizers." *Ind. and Eng. Chem.*, Anal. Edit. 5: 229-34, 1933.

[5] Mehring and Peterson, "The Changing Composition of American Fertilizers." Paper presented before the Fertilizer Section, A.C.S., Chicago, Sept., 1933.

[6] Mehring and Peterson, "The Equivalent Physiological Acidity or Basicity of American Fertilizers." Paper presented before the Ass. of Official Agricultural Chemists, Washington, D. C., Nov. 1933.

[7] MacIntire and Sanders, "The Chemical and Physical Behavior of Certain Synthetic Fertilizer Salts When Mixed With Limestone and Dolomite." *Jour. Amer. Soc. Agron.* 30: 764-70, 1928.

MacIntire and Shuey, "Chemical Changes in Mixtures of Superphosphate With Dolomite and With Limestone." *Ind. and Eng. Chem.* 24: 933-41, 1932

MacIntire, W. H., "Dolomite as a Fertilizer Supplement—Its Behavior and Control." Presented Before Ass. of Official Agricultural Chemists, Washington, D. C., Nov., 1932.

# SLUDGE CONVERSION PROCESS

## Improves Refinery Acid Recovery

By F. J. BARTHOLOMEW

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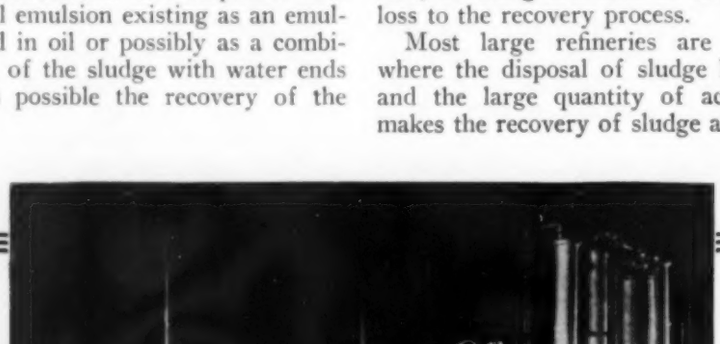
ABOUT 75 years ago, when pioneer refiners were searching for a means to make marketable the products of their simple oil stills, some ingenious worker found that the treatment of "coal oil" with sulphuric acid made a decided improvement in its quality. The use of acid in petroleum refining dates from that time and is practically as old as the industry itself. Research efforts have developed other refining processes that have proved successful, but sulphuric acid remains today the most important refining agent. As a matter of fact, the advent of cracking stills and other similar devices has increased the use of acid and has made necessary the treatment with acid of higher strength, so that today about 25 per cent of the output of the sulphuric acid industry is consumed in the refining of petroleum products.

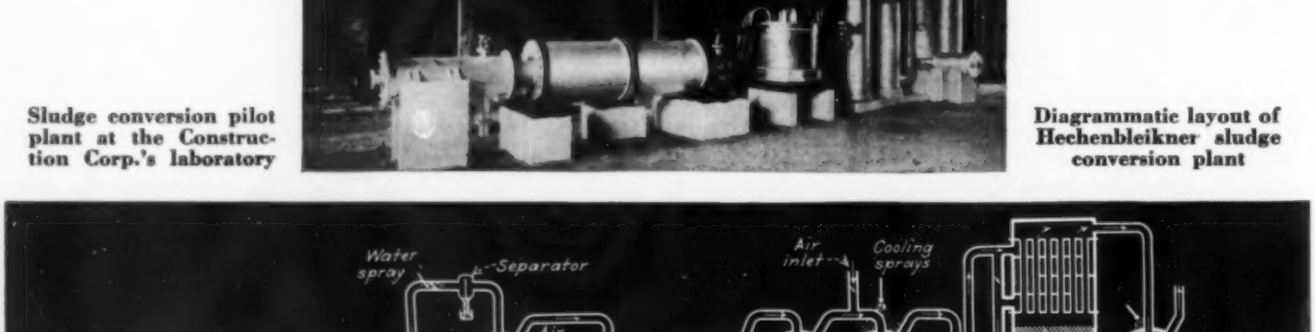
Acid treatment of petroleum distillates results in a heavy liquid called acid sludge which is separated from the oil by settling. Acid sludge is a complex mixture of acid, oil, asphaltic hydrocarbons and sulphuric acid products. It is a colloidal emulsion existing as an emulsion of oil in acid or acid in oil or possibly as a combination of both. Dilution of the sludge with water ends the emulsion and makes possible the recovery of the acid, by reconcentration.

The separation and recovery of sludge acid is not a simple operation. Sludges from lubricating oils are very viscous and not easily hydrolyzed by dilution with water. The treatment of cracked distillates and oils high in aromatic hydrocarbons produces a sludge high in sulphonates. These are dissolved in the separation process and if present in large quantity make reconcentration very difficult if not impossible. Separation under pressure is frequently used to effect hydrolysis of such sludges. As a general rule, open separation of sludge gives the best results when the sludge is diluted to yield an acid of about 35 per cent strength. Lubricating sludges from the treatment of lubricating oils require greater dilution, while pressure separation may yield an acid up to 55 per cent strength. The separation is never quite complete. The acid oil and tar obtained from the separation retain from 1 to 10 per cent of acid and the separated acid retains from 1 to 5 per cent of soluble hydrocarbons which char in the process of concentration, reducing the acid to sulphur dioxide which is a loss to the recovery process.

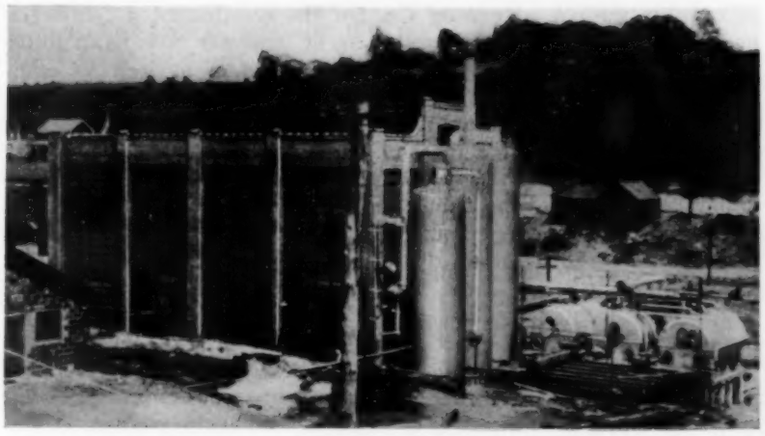
Most large refineries are located in communities where the disposal of sludge by dumping is prohibited and the large quantity of acid consumed in treating makes the recovery of sludge acid economically essential.

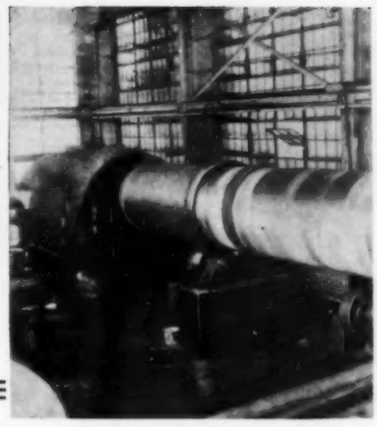


**Sludge conversion pilot plant at the Construction Corp.'s laboratory**




**Diagrammatic layout of Hechenbleikner sludge conversion plant**





**Sludge conversion plant of W. H. Daugherty & Sons Refining Co., of Petrolia, Pa.; the combustion furnace and rotary kiln appear in the view at the right**

The old pan and still method of concentration served the industry for many years, but had many serious shortcomings, including fume damage to surrounding property, high upkeep, low heat efficiency, low concentration yield, and high cost of recovery. About 13 years ago a more efficient process of concentration was developed and the old pan and still method soon went out of use. The new process employed the novel method of blowing hot air through the body of the acid in a covered lead pan thickly lined with acidproof masonry. Heat exchange was almost perfect and the fuel cost remarkably low, concentration being accomplished at temperatures nearly 100 deg. F. under the normal boiling temperature of the acid. Foaming was avoided by conducting the operation in two stages. Cottrell electrical precipitators, operating at high voltage, condensed up to 99 per cent of the acid mist that would otherwise have escaped from the concentrator.

This process proved highly successful and brought some measure of relief to the refiner, but the relief was only temporary. Progress in refining led to the use of cracking stills. Cracked distillates required stronger acid and the resulting sludge became more difficult to separate. The acid obtained from the separation of cracked distillate sludge is frequently so high in soluble hydrocarbons that satisfactory concentration is impossible. Reduction to sulphur dioxide during concentration, due to hydrocarbon impurities in the acid, caused heavy losses, and exit gases from the concentrators were highly objectionable in the community. An increased demand for stronger acid in treating found all concentrating processes unable to measure up to the demand. It is impossible to concentrate separated sludge acid much above 90 per cent strength. For some highly refined products, 98 and even 104 per cent acid is required. The purchase of fuming acid to strengthen partially concentrated acid was impractical in most cases, because the addition of sufficient fuming acid to 80 or 85 per cent acid, to bring the strength up to 98 per cent, resulted in an excess of acid above that required for treating.

At many refineries the sludge is pumped into ponds, with no effort made to recover the acid present. The sludge may be unfit for recovery or the refiner may be unwilling to invest in recovery equipment. This method of disposal is objectionable from more than one standpoint. It is a complete loss not only of the acid, but of the oil in the sludge as well. The ponds are likely to overflow during heavy rains and the levees sometimes break with disastrous results. The handling of the sludge and the upkeep of the ponds entails considerable expense, while the latter constitute a nuisance to the community in which they are located, as $SO_2$ is continually given off.

A few refineries dispose of their sludge by burning. On account of the high acid content of the sludge, its combustion is frequently not self-supporting, and fuel must be added. The heat is sometimes utilized under stills and steam boilers, but deterioration of equipment is rapid and the cost is scarcely worth the gain. Furthermore, the fumes resulting from the burning of sludge are objectionable in a thickly settled community.

A recent development by the Chemical Construction Corp., known as the Hechenbleikner sludge conversion system*, promises to relieve the refiner of his worries with regard to sludge disposal and make feasible its quantitative reduction to $SO_2$ and conversion to new acid of any desired strength. The process is almost as simple as is the manufacture of $H_2SO_4$ direct from sulphur. Furthermore, no appreciable amount of sulphur trioxide is formed in reducing the sludge. This is an important feature, since, as the gases are washed to remove oil and dust, the loss in the process would be considerable if $SO_3$ were present.

Another point of importance favors the process. A small amount of hydrocarbon goes a long way in reducing sulphuric acid to $SO_2$. Consequently, sludge of any strength is suitable for the process. The physical character of the sludge determines to some extent the method of handling. Heavy sludges may be thinned to pumping consistency by mixing with thin sludge in a specially designed mixer. In this way, heavy lubricating

*Also described recently by S. F. Spangler before the American Petroleum Institute, Oct. 26, 1933.

sludge that was separated with great difficulty in the old process is disposed of readily in the new process.

The reduction of the acid in acid sludge to sulphur dioxide is not a new thought. Many patents have been granted for the disposal of sludge and the formation of sulphur dioxide by reduction of refinery sludge, but none have been commercialized, for the reason that they lacked the simplicity peculiar to the new conversion method. Great strides have been made in acid-plant design in the past five years, simplifying the manufacture of acid so greatly that several large refineries, formerly reluctant to engage in such activities, now profitably manufacture their own acid. Vanadium catalyst, which is immune to poisoning, has to a considerable extent replaced platinum for the oxidation of $SO_2$ to $SO_3$. Improvements in contact plant design have helped, more than anything else, to make possible the development of a successful sludge conversion process.

LABORATORY experiments had established a number of pertinent facts.

1. Slow heating of sludge breaks down the acid it contains to $SO_2$. The reaction is practically quantitative with slow and progressive heating. The process must, therefore, be carried out in continuous stages with progressive and controlled heating. The gases include, in addition to the $SO_2$, aqueous vapor, oil and some light hydrocarbon gases that are fixed gases. Therefore, adequate means for cooling, condensing, washing, and drying is necessary, since it is essential that the sulphur dioxide be dry and free from combustible vapors before entering the contact-plant converter.

2. The decomposition of the sludge takes place in successive stages. It foams, turns pasty, and then cokes. The residue is sponge-like and unless crushed down, occupies several times the volume of the original sludge. Furthermore, there is a noticeable peak in the rate of decomposition of the acid and the evolution of gas, taking place at about 390 to 400 deg. F. The utilization of this gas for the manufacture of acid in a contact plant presupposes a steady supply. This is another reason why it is necessary that the process be continuous.

3. The residue from the sludge was found to be brittle in some cases and pasty and asphaltic in other cases. Experience has shown, however, that sludges containing 25 per cent of acid and higher form a coke-like residue easy to handle. Virtually all refineries have sludge mixtures averaging over 25 per cent in acid, thus eliminating the need to add acid from the system to the sludge feed.

4. The reduction is apparently due to the hydrogen atoms of the hydrocarbons, and not to the carbon atoms, as practically no $CO_2$ is formed during the heating. Nor does the reaction produce any appreciable quantities of $SO_3$ or sulphuric acid mist, and very little $H_2S$.

With these facts determined, a pilot plant was designed and erected in 1931 at the engineering laboratory of the Chemical Construction Corp. at Charlotte, N. C. It was designed to handle 2 tons of sludge per 24 hours of continuous operation. Light oil sludge, which remained liquid during transportation, was obtained in tank-car lots and experimental operation continued for a period of nearly a year. The results obtained were very gratifying.

Following demonstrations of the pilot plant, a contract was made with the W. H. Daugherty & Sons Refining Co. for the erection of a commercial plant to produce 50 tons of acid per day from hitherto unseparable medicinal oil sludges at Petrolia, Pa. Erection of this plant was commenced in January, 1932, and operations begun on sludge in June, 1932. Some changes of a mechanical nature have been found necessary, but the success of the process was definitely established by operations on a large scale. The design of the plant of commercial size is in practically all respects similar to that of the pilot plant at Charlotte.

Heat necessary for the decomposition of the sludge is obtained by the combustion of gas or oil in a suitably designed furnace lined with fire brick to withstand a temperature of 2,500 deg. F. or higher. Since the sludge is heated by direct contact, an excess of oxygen is to be avoided in order to prevent combustion of the flammable constituents of the sludge, and for other reasons. A gas of up to 6 per cent $O_2$ appears satisfactory.

Combustion gases leave the furnace at about 2,200 deg. F. and pass directly into a rotary kiln in which the sludge decomposition takes place. The success of the entire process lies in the effectiveness of this simple piece of equipment. The kiln may be of iron or steel, lined or unlined, as desired. It is divided into compartments through which the sludge travels countercurrent to the direction of the hot gases, and is inclined at a slight angle in order to facilitate the flow of sludge in the direction of discharge. Sliding, gas-tight joints, held tight by spring tension, connect the rotary kiln to the stationary ends. The system is operated with the kiln under a slight vacuum so that there is no gas nuisance. The inside of the kiln is provided with ribs which raise the material during its slow rotation. In addition, loose rods or railroad irons rotate with the kiln to prevent caking or the formation of large lumps. The dry, granular material is discharged at the hot end of the kiln, where it falls into a screw conveyor which removes it to a storage bin for future use as a fuel. The granular residue, free from acid, is easily pulverized, and burns with a hot flame. Typical analyses of the residue show volatile matter of 48-50 per cent and thermal values around 11,000 B.t.u. per pound.

If desired, the coke residue may be used as fuel in the sludge conversion system. The quantity of coke obtained from the sludge, which naturally varies with the character of the sludge, is far in excess of the amount of fuel necessary to provide heat for the process.

Even though the combustion gases enter the rotary kiln at 2,200 deg. F., there is no overheating of the material, and it is the aim of the operator to discharge the coke residue at a temperature of about 500 deg. F. The temperature of the gases leaving the kiln is regulated at 250 to 350 deg. F. by varying the rate of sludge feed, air and fuel entering the combustion furnace.

Sludge is pumped into the kiln at the gas exit. The character of the sludge determines the type of pump most suitable. For heavy sludges, screw conveyors or gear pumps have been found satisfactory. For light sludges, reciprocating pumps may be used.

The gas from the rotary kiln is surprisingly high in sulphur dioxide and 15 to 20 per cent $SO_2$ is easily attainable from the average sludge. After the gas leaves the kiln it is cooled by passage through a series of washers which condense the water of reaction and the volatile oils. As the cooling and washing is by direct

contact with water, and as sulphur dioxide is quite soluble in cold water, the loss in the process would be too great if the same water were not used continuously. To make reuse possible the wash water is cooled with water coils. The only water that is discharged from the system is condensate water formed in the decomposition reaction, which water is discharged at high temperature, so the loss from this source becomes negligible.

The water and oil vapors are condensed, the oil overflowing to a receiving tank where it is separated from the water and pumped away for use as a fuel. With some sludges, the oil recovered amounts to a considerable quantity, as shown in the following typical yields:

| | Per Cent | |
|---|---|---|
| | Light Oil Sludge | Heavy Lubricating Sludge |
| $H_2SO_4$ | 53 | 16.8 |
| Coke residue | 23 | 59.8 |
| Total water (free and combined) | 39 | 7.1 |
| Oil | 4 | 12.5 |

The water which condenses is pumped as a fine spray into the gas flue from the kiln and runs to waste at a temperature of about 175 deg. F., at which temperature little sulphur dioxide remains in solution.

A secondary furnace is desirable in some installations to consume, by burning, any oil vapors difficult to condense by cooling and washing, and fixed hydrocarbon gases. A small pilot burner assures combustion of the vapors on their way through the furnace.

After passing through the water washers, the gas is comparatively clean and requires only drying before passing on to the converters. A washer containing sulphuric acid of 85 to 93 per cent strength completes the drying and absorbs the light hydrocarbon gases that pass uncondensed through the first washers. It is important that the gas be completely dry before entering the converter, otherwise sulphuric acid formed by the combination of sulphur trioxide and water vapor will condense in the gas lines and the heat exchanger. The gas entering the dryer is very high in $SO_2$ (10 to 12 per cent), but contains insufficient oxygen for conversion. Consequently, air is drawn into the system at this point to bring the gas to about 8 per cent $SO_2$, 11 per cent oxygen, 4 per cent $CO_2$, and 77 per cent nitrogen.

A centrifugal blower in the system at this point maintains a partial vacuum through the dryer, washers and rotary kiln, thus preventing the escape of $SO_2$ gas into the atmosphere of the plant. From the time the gases leave the blower until they leave the plant, they remain under a pressure furnished by the blower.

The cooled dry gas now enters a simple gas heat exchanger, where it is heated to the conversion temperature of about 450 deg. F. by the $SO_3$ gases leaving the converter. The heat is carefully controlled in the converter so that a conversion of 96 to 98 per cent of the $SO_2$ may be obtained.

If fuming acid is desired, the $SO_3$ gas passes through an absorbing tower in which the acid is maintained at the desired strength, usually about 104.5 per cent. The towers of conventional type in use in standard "Chemico" acid plants are utilized for the absorption of the $SO_3$. But since acid of 97-99 per cent is the ideal absorber for $SO_3$ gas, an absorber of this strength is required for the final clean-up of the gas before it is permitted to escape to the atmosphere. Fuming acid of more than 100 per cent acidity absorbs well, but also fumes badly, so it is necessarily placed before the 98 per cent absorber. The strengths of acids in the drying and absorber towers are maintained at the desired points by the inter-pumping of small quantities of acid from one tower to the other. Excess acid of the desired strength goes to storage for use in the refinery.

A recovery of about 90 per cent of the acid content of the sludge may be expected from this process. With an average refinery treating loss of 10 to 15 per cent of acid, this would give an overall loss of 20 to 25 per cent—a much lower loss than is possible with the best of the old recovery methods. By proper blending and mixing of all the sludges in the average refinery, they will stay liquid enough to be processed. It has been found that sludge acids can be mixed so that they will not stratify if the mixing is done intensively.

In addition, the costs of recovering acid by this method are far less than by the older separation and concentration process.

The plant operating costs for a plant to produce 50 tons of sulphuric acid as its equivalent in oleum, or 98 per cent $H_2SO_4$, based on the average refinery sludge, would be approximately $4 per ton of 100 per cent $H_2SO_4$ equivalent, at recently prevalent unit costs. The estimated daily requirements include as personnel a superintendent, one operator and three helpers per shift; power of 4,000 kw.-hr.; 1,000,000 gal. of water at 75 deg. F.; and 1,500 gal. of fuel oil. These figures do not take into consideration any value for the fuel produced as coke, nor include depreciation and other overhead.

FURTHERMORE, the total acid costs of the refinery may be reduced still further by a simple modification of the conversion process. This is to burn the waste hydrogen sulphide available at many refineries or even purchased sulphur to supply the heat needed for the decomposition of the sludge, thus at the same time, without increased labor or power, producing sufficient additional $SO_2$ to make up the refinery overall acid loss at an added cost equal only to that of the raw material plus a slightly larger investment in catalyst capacity. These costs are more than balanced by elimination of the cost of fuel oil or gas otherwise used for heating the kiln.

This new process of handling sludge will unquestionably appeal to the modern refineries because: (1) It avoids the expense and trouble of separating the acid sludge, with the resultant fume nuisance; (2) it means a substantial saving in treating cost; (3) it produces acid of any desired strength; (4) the coke residue is a fuel of value and in such shape that it can be utilized without difficulty; (5) it provides, for the first time, a satisfactory means of sludge disposal, promising to end for all time one of the worst nuisances in the refinery.

While the results obtained in the Petrolia plant have been highly successful, still further research is being conducted by the developers of the process in a new pilot plant at Warners, N. J., located convenient to supplies of various grades of refinery acid sludges. This plant is being operated with the object of developing the best procedure for handling the entire range of sludges, some of which were not available to the Charlotte plant. Naturally, care has been taken to protect the essential features of the process and special apparatus employed therein by patents issued and pending in all the leading oil-refining countries of the world.

# Resisting HCl Corrosion With Metals

By F. A. ROHRMAN
*Assistant Professor of Chemistry*
*Michigan College of Mining and Technology*
*Houghton, Mich.*

INCREASING large-scale consumption of hydrochloric acid solutions has given the metallurgist and the chemical engineer the problem of developing proper material handling equipment. The yearly production of hydrochloric acid solutions of 18-22 deg. Bé, in the United States alone, is in the order of 250,000 tons. Millions of tons of chlorides, such as sodium chloride, are processed each year; these also present severe corrosion difficulties of similar nature. The avidity of this acid for most metals and alloys and the uncertainty of its behavior with others have made it necessary to employ non-metallic materials for its manufacture, transportation, and use. However, the metallurgist has not been discouraged, and in the last few years some suitable alloys have been placed on the market.

Three factors must be considered in choosing a material for use in contact with hydrochloric acid, the chemical resistance; the cost; and the physical properties such as machineability, workability, strength and weldability.

Obviously, a metal that is not chemically resistant cannot be used, for not only will it be destroyed, but the resulting solution may also cause contamination. If the cost of the material is high it cannot as a rule be used in large installations on account of the large capital tied up. These two factors, therefore, predominate in the determination of the suitability of a metal or an alloy for equipment.

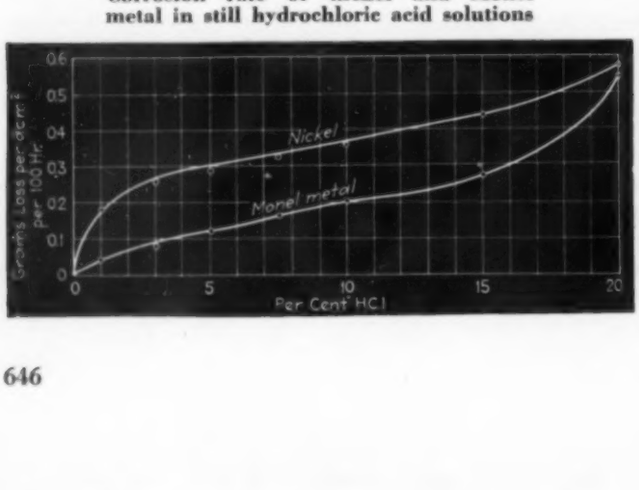
Most common metals and alloys lack the necessary chemical resistance and are rapidly dissolved. Gold, platinum, tantalum, and other noble metals are too expensive. Non-metallic products, such as rubber, silica, stoneware, glass, and others, do not always meet the physical requirements. Lead, silver, antimony, bismuth, and their alloys have often been suggested, but again the poor physical properties of these materials make them undesirable. Furthermore, while the chemical resistance of these metals depends upon a protective film of insoluble chloride or oxychloride, these films are actually neither insoluble in strong solutions nor adherent in dilute solutions.

Among the many metals and alloys which have been manufactured and proposed for use with hydrochloric acid solutions, only a few can be considered practicable, and most of these only under certain specified conditions. After two years' research and investigation, the author and many collaborators would classify the following metals as suitable under certain conditions: Durichlor, Hastelloy A and C, Monel metal, and nickel.

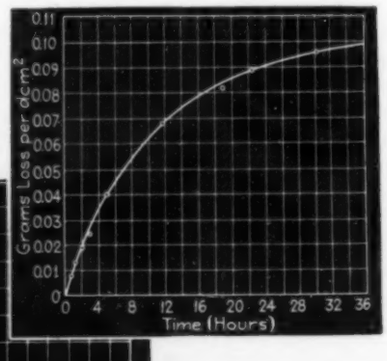
All corrosion, hydrochloric acid or otherwise, is considered to be electrochemical in nature, whereby metal replaces hydrogen ions in solution, the transfer being attended by a flow of current. As all strong acid solutions have a high concentration of hydrogen ions they have a great tendency to react with most metals. High temperature and concentration, oxygen content, circulation rate also tend to increase the rate of solubility of metals.

Most base metals and alloys are able to resist corrosive

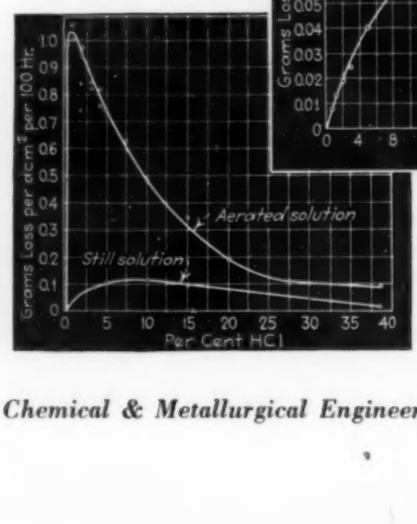
**Corrosion rate of nickel and Monel metal in still hydrochloric acid solutions**




**Behavior of Durichlor in concentrated hydrochloric acid**




**Resistance of Hastelloy to hydrochloric acid**



mediums by virtue of a protective surface film. Concentrated nitric acid will not corrode aluminum as a protective film of $Al_2O_3$ is formed; a protective oxide film likewise makes nickel resistant to acid solutions, and most stainless steels owe their acid resistance to this phenomenon.

With hydrochloric acid solutions, concentrated or dilute, such a protective film cannot form on account of the dissolving action of chlorides on oxides and other surface films. This is the main reason why hydrochloric acid solutions are so corrosive. When this acid is mixed with oxidizing agents such as chlorine, hypochlorous acid, nitric acid, and others, few metals or alloys are able to offer much resistance.

Nickel and Monel metal resist hydrochloric acid solutions to a fair degree, corrosion being generally less pronounced with Monel metal than with nickel. The fact that they possess excellent physical properties as well as a low fabrication cost makes them desirable. As hydrogen is evolved from these metals at the higher acid concentrations they can only be successfully used at the lower concentrations at which the hydrogen attempting to evolve is polarized; until it is depolarized, no corrosion will result. At this stage dissolved oxygen is an important factor, depolarizing the hydrogen, thus allowing corrosion to proceed. Anyone familiar with the corrosion of nickel and Monel metal realizes the importance of dissolved oxygen in corroding mediums such as hydrochloric acid solutions. The slightest change in oxygen concentration will vary the corrosion rate enormously. In the presence of oxidizing agents these metals are not recommended for use, but where the solutions are not agitated in the presence of air or oxygen they can be used successfully.

Typical curves are shown for these metals in varying concentrations of hydrochloric acid at 25 deg. C. without agitation. Most remarkable, however, are the results obtained in solutions subjected to bubbling air and nitrogen. In a solution of 10 per cent hydrochloric acid, without agitation, Monel metal lost 0.2002 grams per sq.dm. per 100 hr., while in an aerated solution this loss was 1.6320 grams. As the bubbling caused circulation the same specimen was later subjected to a similar test, with bubbling nitrogen, in which case the loss was 0.5748 grams. In still, oxygen-free solutions the corrosion rates are negligible. Nickel yielded similar results.

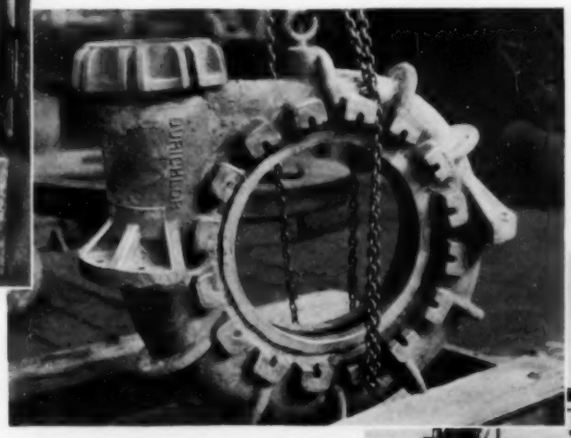
These results show that nickel and Monel metal possess a definite resistance to hydrochloric acid solutions at the lower concentrations and under unaerated and non-oxidizing conditions. Monel metal is being used for pickling tanks, baskets, and hooks where dilute hydrochloric acid solutions are employed. Here is shown a group of Monel metal pickling baskets, still in good condition after 8-15 yr. use in dilute hydrochloric acid, and longer service is not uncommon. The same materials are used extensively in sodium chloride solutions; most of the salt dryers used in the industry are lined with Monel metal.

Hastelloys A and C are alloys of high molybdenum content, while Hastelloy D is a nickel-silicon alloy. The compositions of the Hastelloys are approximately as follows: Hastelloy A, 58 per cent Ni, 20 Mo, 20 Fe, 2 Mn; Hastelloy C, 58 per cent Ni, 17 Mo, 6 Fe, 14 Cr, 5 W; Hastelloy D, 85 per cent Ni, 10 Si, 3 Cu, 2 Al.

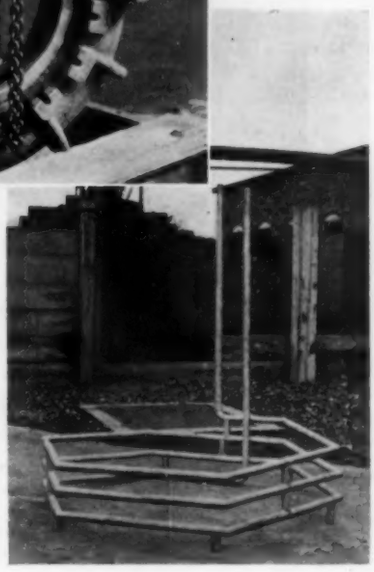
Hastelloys A and C have excellent physical properties, while Hastelloy D cannot be machined or worked under ordinary conditions. The first two alloys are quite resistant to all concentrations and temperatures of hydrochloric acid, Hastelloy D only to the low concentrations —in fact, it is rarely recommended for this purpose.

It was early observed that the corrosion resistance of nickel is greatly increased by alloying with molybdenum. This resistance seemed to reach a maximum at 15-20

**Monel metal pickling baskets still in good condition after daily service from 8 to 15 yr. at the Fanner Manufacturing Co.'s Cleveland plant**



**Above — A large Durichlor pump casing for handling hydrochloric acid**



**Right — A heating coil fabricated from Hastelloy A for resisting hydrochloric acid**

per cent molybdenum. Substitution of iron for nickel seemed to improve the physical properties; consequently Hastelloy A was developed. This alloy is very satisfactory for hydrochloric acid solutions, but the solution rate is increased in the presence of oxygen or oxidizing agents. Substitution of chromium and tungsten for most of the iron in Hastelloy A led to the development of Hastelloy C, an alloy very resistant to hydrochloric acid containing oxygen or oxidizing agents such as hypochloric acid or chlorine. It is only attacked slowly by aqua regia.

The curve gives the corrosion rate of Hastelloy A in hydrochloric solutions under the most adverse oxygen concentrations. The curve reveals the peculiar fact that the greatest corrosion is experienced at the lower acid concentrations. Under normal conditions the corrosion rate is much lower, as the other curve shows. At the higher temperatures the rate is somewhat higher.

The corrosion rate of Hastelloy C is of somewhat the same order as that of Hastelloy A. As previously mentioned, this alloy is primarily useful in the presence of oxidizing agents and does not, like Hastelloy A, present a maximum. The Hastelloys have been fabricated into hydrochloric acid pumps, heating coils, injectors, valves, exhaust fans, piping, and other equipment. Another illustration shows a large heating coil used for hydrochloric acid solutions.

One of the most recent alloys developed for hydrochloric acid is Durichlor, which has a composition of approximately 81 per cent Fe, 14.5 Si, 3.5 Mo, and 1.0 per cent Ni. This alloy was discovered by the Duriron Company during tests to improve Duriron. It turned out to be highly resistant to hydrochloric acid, and has in addition better physical properties than most of the silicon irons. It is extremely hard and has great resistance to abrasion, is not machinable or workable, but can easily be cast into many designs and fitted by grinding. Why this alloy resists hydrochloric acid is an interesting theoretical problem. It is believed by the manufacturers that a film of insoluble molybdenum chloride is formed; it is also probable that highly insoluble silicides of iron are formed which present an insoluble matrix in the alloy. Again, both factors may be exerting their influence to make the alloy insoluble.

This allow presents most unusual hydrochloric acid resisting properties. At first the corrosion rate is high; then it gradually falls off until after a number of hours it becomes almost zero. Its behavior in concentrated hydrochloric acid at 25 deg. C. is shown in an accompanying diagram. For the first 10 hr. the corrosion rate is seen to be rapid, to become negligible after 30-35 hr. The effect of more dilute solutions is to lengthen the time before zero corrosion rate is reached. At higher temperatures of the acid the curve flattens out much more rapidly. After prolonged immersion the alloy shows a porous, gray-colored surface film, if this film is removed corrosion will continue until a new film is formed.

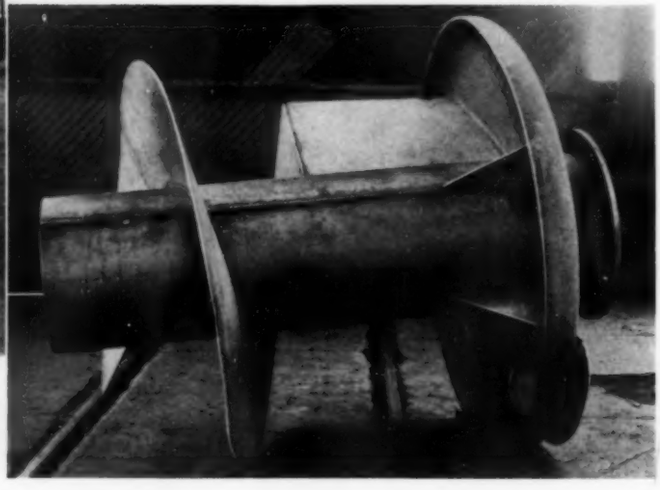
Prospective customers and testers may make the error of testing this metal for only a few hours before the protective film is formed, and thus underestimate its chemical resistance. A test on this metal as well as on other metals should be run for a long time to permit more accurate conclusions. It is not affected by ordinary oxidizing agents. A large Durichlor pump casing of several hundred pounds' weight, to be used for hydrochloric acid solutions, is shown here. Other fabricated pieces are valves, pipes and fittings, exhaust fans, circulating jets, condensers, and etching dishes.

▼ ▼ ▼

# Fatty Acid Separator of Unique Construction

**Parts of a Wurster & Sanger centrifugal separator in the soap works of Armour & Co. used for the recovery of pure glycerine, a byproduct in the soap making process**

**Helical element and stave-constructed inner shell of a Flick separator made of 18-8 chrome-nickel steel. The outer shell, inlet and top center outlet pipe made of Ing-O-Clad steel of similar composition**



# BOOKSHELF

## Metallurgical Principles

THE PRINCIPLES OF METALLURGY. By *Donald M. Liddell* and *Gilbert E. Doan*. McGraw-Hill Book Co., Inc., New York. 626 pages. Price, $5.50.
Reviewed by *B. H. Strom*.

IN THE PRESENT treatise the authors aim to furnish a textbook for the engineering student, as well as a handbook and quick reference volume for the practicing metallurgist's library. Among the important subjects discussed are ores; slags and fluxes; refractories; fuels; air and water supply; extraction processes, including pyrometallurgical, hydrometallurgical, and electrometallurgical procedures; briquetting and sampling; dust control; and pyrometry. An entire section, a little less than half of the book, has been devoted to physical metallurgy.

The value of the book would undoubtedly have been greater if more space had been devoted to the chapters on extraction processes; the discussion of blast furnace smelting is very brief and deals almost entirely with the treatment of iron ores; practically nothing is said about reverberatory smelting, and the latest development in roasting, flash roasting, is not included. The treatment of electrothermic processes might also have been more extended, and much more could be said on such an important operation as filtration.

With the rapidly growing interest in physical metallurgy the last section of the book is timely. Important constitutional diagrams have been interpreted, the properties of metals and alloys are explained in the light of the modern atomic theory, and the latest development in X-ray research are utilized in explaining the metallic structure. Space is also given to fabrication and treatment, to description of important modern alloys, to corrosion, and to physical testing.

THE MINERAL INDUSTRY DURING 1932. Vol. 41. Edited by G. A. Roush. McGraw-Hill Book Co., New York. 680 pages. Price, $12.

DEVELOPMENTS of the past year in each individual field of the metallic and the non-metallic industries have been covered. With the depressed industrial condition, many plants being idle or greatly curtailed, there has been less to report, and the volume has shrunk somewhat in size, but the number of subjects covered and the general arrangement remain practically unchanged. Progressive decrease in sales of the volume during the past three years finally led to a situation where publication could not continue under the existing conditions. Fortunately, threatening suspension was averted when provisions were made whereby American Institute of Mining and Metallurgical Engineers pledged a certain sum from the Rocky Mountain Fund, to be applied against any possible loss in the publication of this year's volume.

## Rubber Latex for Industry

LATEX AND ITS INDUSTRIAL APPLICATIONS. By *Frederick Marchionna*. Rubber Age Publishing Co., New York. 1,037 pages. Price, $15.
Reviewed by *Robert W. Eldridge*.

IN STEP WITH the rapid growth of industrial uses for rubber latex during recent years, the literature on the subject, particularly on patents, has been mounting at an ever-increasing rate. Mr. Marchionna has performed a real service to industry by compiling a comprehensive survey of the art relating to this important subject.

The volume comprises full and detailed abstracts of all patents issued in the United States, Great Britain, France, and Germany through June, 1932, and of the journal articles published to July, 1929. The abstracts number about 2,500, of which perhaps 1,900 are patents. These are indexed alphabetically by subject, patentee, and author, and chronologically by country of issue.

Each chapter begins with a general discussion of the history and principles of the subject at hand, written by the author (with one exception.) Although it is a mine of information, the book is imperfectly adapted for rapid reference, due to the methods chosen for arranging and classifying the subject matter, and to the inadequacy of the subject index.

The classification of patents has been carried out with frequent disregard of the main point or essence of the inventions. References to the preparation of crude rubber are divided indiscriminately between the chapter on coagulation and that on the preparation of rubber. The various methods of concentrating latex, such as creaming, centrifugation, evaporation and filtration, are included mostly in one section, without any subordinate grouping, but are also found to some extent scattered through several other chapters. The chapter on preservation of latex and rubber contains references not only to methods of inhibiting bacterial growth, but also numerous references of which the primary features include antioxidants, stabilizing agents, thickening agents, partial coagulation, methods of creaming, and methods for modifying the properties of coagulated rubber by prior treatment of latex involving none of the above features.

The chapter on direct use of latex, containing over half of the total number of abstracts, is most enlightening as to the myriad applications which are being found for this interesting material in widely diversified industries.

Segregation of much of the material into smaller and more unified groups would have been a boon to the hurried searcher—for example, the splitting up of the section devoted to fibrous products, which now includes such varied subjects as the use of latex in methods for the production of paper and of artificial leather; the coating of pre-formed paper; the impregnation of yarns, cords, and fabrics; and the molding of fibrous plastics. More serious is the grouping of over one-quarter of all the abstracts under "Miscellaneous." Surely dipping processes (81 abstracts) and the production of sponge rubber (50 abstracts) might have been accorded separate space. Many of the abstracts in this section come within the scope of other present sections or chapters.

Cognate patents issued in different countries on the same invention appear on widely separated pages, without cross-reference, in the same chapter or even in different chapters.

It would be helpful if the headings of the individual abstracts were more conspicuous and were more informative as to the specific nature of the subject. Headings of frequent occurrence are "Treating Latex" and others of similar vagueness. The country of issue should have been given before each patent number, or at least at the top of each page, to obviate the annoyance of having to look back several pages to find it. Other omissions are the initials of inventors, and the names of co-inventors as well as of assignees.

Rapid finding of references would also be facilitated by the inclusion of concise opening statements of the essence of each patent or article, followed in separate paragraphs by the discussion of examples, equivalents, and other details. The fullness of detail given, however, is to be highly commended, often making reference to the original unnecessary.

The utility of any such bibliography as this can be said to be directly proportional to the completeness and care

with which the subject index has been prepared. At first glance the subject index of the book appears to be quite extensive, covering as it does, 60 pages. However, it might well have covered 200 pages. In far too many instances, from 10 to 60 references are listed under a single subject heading without any subordinate headings, making the search for a given reference most laborious. The lists of abstract serial numbers following each subject entry are often incomplete.

It will be found that at least a hundred subjects contained in the abstracts are not listed in the index at all. Some of the omissions are: reversible latex pastes, phase inversion, water-in-oil type rubber dispersions, latent coagulants, heat-sensitized latex, dialysis, evaporation, mordanting of fiber pulps, nitrogen-free rubber, fiber board, gelling agents, tire cord, tire fabric, centrifugal molding, and latex froth, to mention only a few.

The misalignment of parallel index headings and the capitalization of subordinate headings create some confusion. The method of listing organic compounds varies widely from that used by *Chemical Abstracts*.

In spite of its shortcomings the book is a monumental work and will be invaluable to every latex technologist as well as to those in the ever-widening circle of industries in which latex is finding new applications.

SICHERHEITSGLAS (SAFETY GLASS). By *H. G. Bodenbender*. Chemischtechnischer Verlag Dr. Bodenbender, Berlin-Steglitz. 320 pages. Price, 18 Rm.

INCREASING DEMANDS for safety in the automotive industry and in aeronautics are rapidly bringing the nonbreakable glasses to the foreground. This book should therefore fill a definite need. A brief review of the historical development is followed by description of the numerous types of glasses and a thorough treatment of the processes involved in their fabrication. For those interested in entering this field a chapter on planning, erecting, and equipping a plant has been added. Other chapters include an outline of the physical properties of the many types of glasses, methods for testing, applications, and a complete list of patents issued.

PRECIPITATED CHALK—History, Manufacture, Standardization. By *A. P. Wilson*. Birmingham, England: John & E. Sturge. 51 pages. Price, 2s. 6d.

THIS ATTRACTIVE and well-arranged booklet describes the geological formation of limestone deposits from which precipitated chalk is manufactured, the properties of the product, methods of testing, determination of physical and chemical characteristics and table of densities. It is well illustrated with photomicrographs; and, although carrying frequent references to Sturges chalk products, it contains much of general technical interest and value.

SYMPOSIUM ON AIR CONDITIONING. Western Conference on Air Conditioning, San Francisco Section, A.S.M.E. For sale by A. P. Huhn, Treas., San Francisco Section, A.S.M.E., 79 Beaver St., San Francisco, Calif. Price, $1.

UNDER THE AUSPICES of the San Francisco Section of the A.S.M.E. the Western Conference on Air Conditioning was held recently at the University of California. So much interest was expressed in the 16 papers presented that it was decided to reprint the entire list in a single pamphlet. Papers cover many phases of air conditioning, from the basic theory to the more specific matters of house insulation, installation design, cooling, air infiltration, and kindred subjects.

BULLETIN OF THE NATIONAL RESEARCH COUNCIL. 5th Edition. Compiled by *C. J. West* and *C. Hull*. Published by the National Research Council, Washington, D. C. 223 pages. Price, $2.

INFORMATION REGARDING 1,575 industrial and consulting laboratories, with a total staff of about 25,000 workers, has been given in this issue. The list, which may be considered correct up to Jan. 1, 1933, does not include laboratories connected with federal, state, or municipal governments.

TRANSACTIONS OF THE INSTITUTION OF CHEMICAL ENGINEERS. Vol. 10, 1932. Published by Institution of Chemical Engineers, London, England. 191 pages.

AMONG THE important papers in the volume may be mentioned: Production of Hydrogen and Oxygen by Electrolysis at High Pressures, by D. M. Newitt and H. K. Sen; Thermal Insulation, by Ezer Griffiths; Coal Distillation in Rotary Retorts, by Harald Nielsen; Fluid Friction and Its Relation to Heat Transfer, by C. M. White; Chemical Engineering; and the Aircraft Industry, by H. T. Tizard.

## GOVERNMENT PUBLICATIONS

*Documents are available at prices indicated from Superintendent of Documents, Government Printing office, Washington, D. C. Send cash or money order; stamps and personal checks not accepted. When no price is indicated pamphlet is free and should be ordered from bureau responsible for its issue.*

*Cement Industry.* Senate Document No. 71, 73rd Congress, 1st Session. Report relative to competitive conditions.

*Mineral Deposits Near the West Fork of the Chulitna River, Alaska, by* Clyde P. Ross. U. S. Geological Survey Bulletin 849-E; 15 cents.

*Essentials for a Preliminary Report on a Small Lode-Gold Mine or Prospect, With Notes on Sampling,* by C. W. Wright. Bureau of Mines, Information Circular 6748; mimeographed.

*Microbiological Studies of Salt in Relation to the Reddening of Salted Hides,* by L. S. Stuart and others. Department of Agriculture, Technical Bulletin 383; 5 cents.

*Variety Tests of Sugarcanes in Louisiana During the Crop Year 1931-32,* by George Arceneaux. Department of Agriculture, Circular 298; 5 cents.

*The Effect of Different Colloidal Soil Materials on the Efficiency of Superphosphate,* by Philip L. Gile. Department of Agriculture, Technical Bulletin 371; 5 cents.

*The Decomposition of Hydrolytic Peat Products Including Ammoniated Peat,* by I. C. Feustel and H. G. Byers, Department of Agriculture, Technical Bulletin 389; 5 cents.

*Testing Milk and Cream,* by Philip A. Wright. Department of Agriculture, Miscellaneous Publication No. 161; 5 cents.

*Distribution of Mottled Enamel in the United States,* by H. Trendley Dean. Public Health Service, Reprint No. 1581 from Public Health Reports; 5 cents. Important with reference to water supply.

*Animal and Vegetable Fats and Oils.* Bureau of the Census, unnumbered pamphlet; 5 cents. Statistics of production, consumption, imports, exports and stocks by quarters, calendar years 1928 to 1932.

*Federal Specifications.* New or revised specifications of the Federal Specifications Board on: Acetone, O-A-51a; Pitch, coal-tar (for) mineral-surfaced built-up roofing, waterproofing and damp-proofing, R-P-381. The above specifications are available from the Bureau of Supplies and Accounts, Navy Department.

*Coal-Tar Crudes.* Tariff Commission Release, November 13, 1933; mimeographed. Preliminary résumé of 1932 production, sales, imports, and exports statistics.

*Wages and Hours of Labor in Rayon and Other Synthetic Yarn Manufacturing, 1932.* Bureau of Labor Statistics Bulletin 587; 5 cents.

*Wages and Hours of Labor in the Leather Industry, 1932.* Bureau of Labor Statistics, Bulletin 589; 10 cents.

*Production Statistics From 1931 Census of Manufactures*—printed pamphlets on: Petroleum refining and lubricating oils and greases not made in petroleum refineries: Glass mirrors and other glass products made of purchased glass; Drug industries; Tanning materials, natural dyestuffs, mordants and assistants, and sizes; Fertilizers; 5 cents each.

*Minerals Yearbook.* Separates from Bureau of Mines Minerals Yearbook, 1932-33, giving statistics for the calendar year 1932, are available for the following commodities on which final statistics are ready (other chapters involving revisions will provide supplementary pamphlets later). Those now available are: Abrasive Materials; Antimony; Arsenic; Asbestos; Asphalt; Barite and Barium Products; Bauxite and Aluminum; Carbon Black; Chromite; Copper; Feldspar; Fluorspar and Cryolite; Fuel Briquets; Fuller's earth; Gypsum (subject to revision); Iron Ore, Pig Iron, Ferroalloys and Steel; Lead; Lead and Zinc Pigments and Zinc Salts; Magnesium and Its Compounds; Manganese and Manganiferous Ores; Mercury; Minor Metals (beryllium, bismuth, cadmium, cobalt, selenium, tantalum, tellurium, titanium, and zirconium); Molybdenum; Natural Sodium Compounds; Nickel; Platinum and Allied Metals; Potash; Radium, Uranium, and Vanadium; Salt, Bromine, Calcium Chloride, and Iodine; Secondary Metals; Sulphur and Pyrites; Talc and Soapstone; Tin; Tungsten; Zinc.

# Ringing Out Depression at the Chemical Show

THE FOURTEENTH EXPOSITION of Chemical Industries has come and gone and the industry has again settled down to its work-a-day existence, away from the tinsel and hangings that always betoken the "Show," content in the knowledge that interest in what is new has come through the depression without visible diminution. There were fewer exhibitors—fewer by a third than in 1931—and it was unfortunate to find a good many former leaders among the missing, but the 220 odd exhibitors that were present had, in the main, outdone themselves, both in the quality and ingenuity of the materials and equipment shown, and in the methods of presentation. Certainly the crowds, reminiscent of old times, found nothing of which to complain in the fact that but two of the usual three floors of the Grand Central Palace were occupied.

If it were possible to cover in this report all that was new since the last Show, we should have to encompass practically everything on exhibit. However, limitations on space make it imperative to cover only those developments of which *Chem. & Met.* has not previously taken note, only those dealing with plant equipment, and with materials for plant use. Thus, unavoidably, we eliminate that notable display of "Children of the Depression" sponsored by the American Chemical Society. We must eliminate many important showings of materials used primarily for consumer products, notably the plastics; we must omit many impressive new pieces of laboratory equipment. Furthermore, since so many developments are to be considered, it will be impossible to do justice to them here and a considerable number will later be the subject of equipment articles, some few of which appear this month in the section which follows.

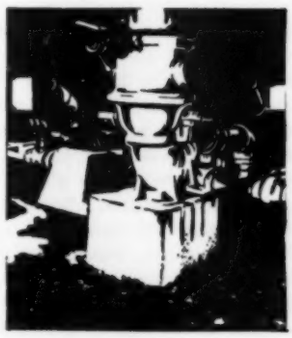
### Mixing Makes Advances

Certain of the most striking advances are to be found in the group of devices for accomplishing various phases of mixing. Baker Perkins Co. was responsible for three of these, the first of which was a heavy-duty intensive mixer capable of applying 25 hp. to a plastic charge of only 3 gal. This mixer employs a new dispersion-type smearing blade of heavy construction, packingless glands, temperature control on the jacket and a hydraulically lifted compression cover. A dust cover automatically seats itself when the compression cover, which rides on the material to be mixed, is lowered. The gearing is of the helical herringbone type and the tilt mechanism powered by a separate motor.

This same company's new change-can mixer, the Rotacan, is an important departure. The agitator, set off center as is usual in this type of mixer, is tipped out of the can instead of being lifted. The result is extreme compactness and rigidity. In a modification of the company's Vissolver which was shown, called the rapid dissolver, a flared screen and draft tube are used, giving much larger screen area to permit handling of materials that tend to gum.

Numerous small mixers consisting of a propellor inserted more or less horizontally into the bottom of a tank have been built in the past, but the Turbula mixer shown by General Ceramics Co., the invention of W. H. Jackson, differs from its predecessors in a number of important respects. The tank is a round-bottom chemical stoneware vessel supplied with an opening into which the motor-propeller assembly is fitted. By the use of a long bearing, part babbitted, a stuffing box is avoided. The shaft has sufficient clearance to permit steaming out, and yet is tight against leakage. The propellor is much like the three-bladed variety used for airplanes and is so designed as to give a high forward velocity of the material without appreciable side component.

Turbo Mixer Corp. showed several new developments, one a simple multi-bladed propellor without shrouds which is said to be highly effective with extremely viscous materials. Another, for the dispersing of paint pigments, employs a multibladed scraper-like element rotating within a perforated ring. Perhaps the most interesting of the lot is the new Turbo oxidizer, a device which is more properly classified as a contactor for gases and liquids than as a mixer. A horizontal, dome-shaped element, open at the center, is suspended in the tank at the liquid surface. Around its periphery on the lower side are a number of stationary radial blades within which an impeller rotates. Whatever gas is above the liquid surface is drawn through the opening in the dome, mixed with the liquid by the impeller and discharged outward and downward. The result is an intimate contacting in which practically the entire contents of the tank takes part.



New England Tank & Tower Co. showed a new paint mixer for small batches, made in sizes of 2 and 5 gal. in which the can rotates at 230 r.p.m. around two stationary Z type agitators. The base of the mixer conceals a belt which drives the can from a vertical motor mounted on the base.

The Pfaudler Co. brought out its new Multimixer, a small mixer for creams and pastes, built in 10 and 20 gal. sizes. The agitator is of the epicyclic type, arranged to lift out of the glass enameled vessel so that the latter can be tipped to discharge its load. The agitator is readily replaceable with others to cover a variety of needs.

### Drying Shows Refinement

Drying equipment, unfortunately, was not so well represented as usual. What there was showed evidence of considerable refinement, however. Among the Proctor & Schwartz dryers, a number of interesting features were displayed. One was the use, wherever possible, of a new overhung motor supplied with an outboard bearing contained within a casting attached to the motor end. By this device, any motor, with its attached fan, may be withdrawn as a unit. Installed, the motor is kept outside the dryer shell, while the fan is located within the air passages. The shaft, interestingly enough, is air cooled. This company is now employing finned tubing, a comparatively recent application in air dryers. Another feature, used in truck and shelf dryers, is an automatic periodic reversal of the air, accomplished by a cycle controller.

Buffalo Foundry & Machine Co. showed an improved double-drum dryer with heavily chromium plated drums. To accomplish this plating job, it was necessary to develop an entirely new cast iron of special structure. This dryer uses a new self-aligning sleeve bearing, stainless steel trimmings and a peg or "porcupine" type feeder consisting of a rotating horizontal element studded with numerous prongs dipping into the feed material. The material is thrown forcibly against the drying drums where the resultant coating is said to be bet-

ter, as a result of the impingement, than coatings previously attainable.

Developments among filter manufacturers were not as much in evidence as might have been expected. Oliver United Filters showed a new pressure leaf filter for clarification work in which the container is a vertical cylinder and the leaves stationarily mounted therein. The cake, which is generally not recovered in the type of work for which this clarifier is suited, is flushed from the leaves manually, this operation being facilitated by the counter-balancing of the pressure-tight cover. This company has simplified the design of the drive used on its vacuum filters in some of the larger installations, employing individual motor drives for the various filter parts and accessories.

Filter accessories of one sort or another were more numerous. T. Shriver & Co. showed Haveg plates and frames for filter presses. John A. Roebling's Sons Co. exhibited a newly rounded-out line of metallic filter cloth made in stainless steel, copper, tin and Monel metal. The Multi-Metal Wire Cloth Co. showed a 16-ft. diam. filter blanket in one piece and a screen capable of stopping particles of 0.0002 in., the latter made from pure nickel and weighing 15 oz. per sq.ft. This fine filtration is accomplished by the use of overlapped wires which entrap the material being filtered. A peculiar feature of this cloth is that it has 1½ in. of wire per inch of width. Another screen furnished by this company, which is said to be the finest ever made, is woven from Monel and has 100 wires per inch in one direction and 1,000 wires per inch in the other direction.

Glass filter specialties, several of them not yet out of the curiosity stage, were shown by the Owens-Illinois Glass Co. Among these were a number of filter fabrics produced from fine glass wool and employing a hard-rubber binder. Depending on requirements, it is possible to produce a fabric for separations as fine as 0.25 micron with fiber sizes as small as 2-3 microns. This company also showed new glass-fiber air filters, eliminator plates for air washers, and glass accoustic pads.

### Oil De-Emulsifier Shown

Developments in heat technology and transfer were also somewhat scarce. National Radiator Co., in addition to its improved line of cast-iron heating and cooling sections, showed a new oil de-emulsifier consisting of a sectional cast-iron heater, gas-fired, operated in conjunction with a counter-current heat exchanger. By heating the emulsified oil and then cooling it in the heat exchanger, the emulsion can be broken and the water removed.

A distinctly novel piece of stoneware appeared in the disk-type cooler for chlorine and other gases shown by Maurice A. Knight. This cooler, for use either submerged in a tank or tower, or subjected to water sprays, consists of thin-walled, stoneware disk sections through which the gas passes over an extended path from a center inlet to a center discharge. The surface in this type of cooler is very large in proportion to the volume occupied.

Freas Thermo-Electric Co. showed, among its new ovens, one form for maintaining constant humidity by means of forced circulation in conjunction with wet- and dry-bulb control and a spray chamber. The construction is of stainless steel throughout and adapted to tight sealing during operation.

### New Instruments Numerous

Prolific as usual, the instrument manufacturers showed many new designs. The most ingenious among these were the several new potentiometer recorders. One, the Leeds & Northrup Speedomax, is notable for the fact that it has no galvanometer. By means of a purely electrical method of balancing, in conjunction with electronic tubes, this new recorder is capable of moving its pen across the chart in less than 2 seconds. The company also showed a new radiation pyrometer in which the pyrometer tube may be provided, if desired, with a water-cooled jacket for installation near a furnace or kiln.

Another new recording potentiometer, also using electronic tubes, was that shown by the Bailey Meter Co. This device employs a galvanometer but does away with the customary "inching" mechanisms for balancing. By the use of the electronic tubes, relays are also avoided. Balancing is accomplished by means of a reversing synchronous motor which is controlled by high or low contacts, depending on whether the potentiometer is unbalanced on the high or low side. The magnitude of unbalance determines the duration of contact, and hence the amount of adjustment applied to the slide wire and amount of movement of the pen.

This same company has, for the first time, introduced a line of air-operated controllers, used for regulating temperature, pressure, fluid flow, fluid level and other variables.

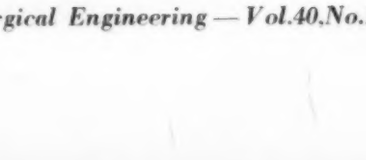
The Foxboro Co. is another concern showing a new potentiometer recorder. Like certain of its predecessors, this instrument employs sensing fingers to determine the location of the galvanometer pointer. Unlike them, however, the new instrument translates the location of these fingers into motion of the pen and adjustment of the slide wire through the peculiar action of a V-shaped cam which rotates a roller by an amount directly proportional to the deviation.

New hygrometers of both the wet- and dry-bulb and hair type were shown by the Brown Instrument Co. This company also displayed a trend analyzing potentiometer equipped with a five-point contact table and a new line of mercury-contact electric controllers for temperature, pressure, fluid flow, etc. In the latter, the sensitive element does not position the mercury switch. This is accomplished periodically at 6-second intervals by means of the clock motor, thus imposing no drag on the sensitive element and recording-pen system.

A new diaphragm valve for control is said by The Bristol Co. to be one of its outstanding achievements. Its most important feature is the elimination of hysterisis, through redesign of the spring and diaphragm system. The diaphragm is molded and the spring of short and heavy design. As a consequence, it is claimed that the valve opening for a given diaphragm pressure is exactly the same when the pressure is ascending as when it is descending. This company is showing a new pyrometer controller equipped with motor-operated mercury contacts. It has also developed a new distant-recording mechanism, the Metameter, which operates over any two-wire system, such as the telephone wires, using a rectified alternating current of 6 volts and 40 milliamps. It is practically unlimited in the distance over which it can operate.

General Electric Co. showed an interesting automatic weighing device consisting of a Toledo scale controlled by a photoelectric cell in conjunction with a Traylor vibrating feeder. Illinois Testing Laboratories showed two new pyrometers, both employing thermocouples and automatic cold-junction compensators. One is intended for the measurement of roll temperatures and the other is provided with four interchangeable thermocouples for various services such as the determination of temperatures of rolls, plates and plastic materials.

Sarco Co. exhibited improved fluid-operated regulators and a new precision electric regulator. The accuracy claimed is 0.5 deg. F. and instruments are obtainable in various ranges between — 40 and + 1,000 deg. F. Several sorts of contact-making thermometers including liquid, gas and bimetallic sys-



tems are employed. The regulating valve is adjusted by a heat motor consisting of a heating unit which vaporizes a fluid and compresses a bellows attached to the valve stem. Throttling action is obtained by the use of from one to six current-breaking contacts attached to the valve stem.

Among the separation devices other than filters were a number of interesting developments in centrifugal machinery. Sharples Specialty Co. showed a laboratory centrifuge which has been speeded up to 50,000 r.p.m. DeLaval Separator Co. featured an improved industrial centrifugal separator, the lines of which had been very effectively refined. In the new design, the motor is mounted directly on the base casting, driving the bowl through a wood-block friction clutch. The crane member for removing the bowl has been attached directly to the body so that the entire apparatus is of unit construction. Rochester Engineering & Centrifugal Corp. showed a removable type basket which is said to be well known in textile and laundry practice, but practically new in chemical plants. This machine is of the under-driven type, employing a basket of conventional design within which the removable basket fits. The latter is made in two halves which are separable so that a half basket and its contents may be conveyed to one part of the plant and half to another.

Among the devices for mechanical separation, was a new countercurrent classifier developed by the Hardinge Co. This machine is used for the same purposes as rake-type classifiers, but is totally different in construction. It consists of a rotating drum containing a continuous helical flight attached to the drum and revolving with it. The drum is set on a slant so that when solids are fed into the lower end, countercurrent to the water which is fed at the upper end, the raking action of the flight results in delivery of the fines at the lower end and of the coarse materials at the upper end.

Orville Simpson Co. showed its new No. 43 screener in which a number of improvements have been made. Among these may be mentioned the use of a quick-unlocking device on the cover and molded rubber caps for the inspection openings. Another screen manufacturer, the Productive Equipment Corp., showed two recent improvements. One of these is known as the Jigger Fluffer and consists in the addition of a number of special concave rubber "fluffers" which play on top of the screen cloth when the screen is in operation. These rubbers also move about so as to come in contact with the entire cloth surface, thus breaking up the inter-particle attraction which is common in many fine powders, causing them to ball and mat and make screening difficult. The second improvement is an automatic cleaner comprising a simple device for brushing the under side of the cloth in both directions. Beneath the cloth are installed chains carrying brushes which move back and forth longitudinally at an adjustable rate.

For a different class of operation, the Abbe Engineering Co. has introduced a new midget Blutergess sifter, the principle of which will be recalled from earlier descriptions in *Chem. & Met.* The new midget employs a single turbine for throwing the material to be screened against the cylindrical bolting cloth and operates from a direct-connected vertical motor. Its capacity is 25 to 100 lb. per hour.

### Pump Designers Active

Numerous improvements were noted in pumps and associated liquid-handling equipment. The LaBour Co. introduced a new cantilever bracket for its centrifugal pumps which is now used for severe service both with the self-priming and non-self-priming types. By this method, the pump is supported by a bracket which extends from the base above, instead of below, the shaft so that any unavoidable leakage from the stuffing box will not come in contact with this vital part of the framework. The Deming Pump Co. showed a new endwise adjustment on the shaft of its horizontal centrifugal pumps. F. J. Stokes Machine Co. has added to its line of standard high-vacuum pumps a small centrifugal separator which is used to remove water from the oil employed to seal the pump rotor. It was discovered in attempting to develop high vacuum in cases where a small quantity of water might enter the oil, as in the evacuation of dryers, that the presence of this water prevents the attainment of vacuua in the neighborhood of 10 microns. With the addition of the clarifier, it has been possible to attain this end.

The Duriron Co. has developed a complete new line of centrifugal pumps containing many improvements. These pumps are available in sizes ranging from 1 in. to 4x3 in. and in all the metals now used by this company. The pump casing is supported between flanges and may be removed and replaced readily. The steel impeller shaft is encased in a tapered sleeve of corrosion-resisting metal which passes through the stuffing box, this taper practically eliminating pressure on the stuffing box. The impeller, which is now of the closed type, has a non-overloading characteristic and is designed to exert a slight suction on the stuffing box. The bearings are babbitted, replaceable and ring-oiled.

Another job of pump redesign is that of the U. S. Stoneware Co. which has a new line of stoneware centrifugal pumps operating at 1,750 r.p.m. The pumps are much more compact than their predecessors, occupying no more space than a metal pump of equal capacity. Furthermore, it is claimed that their efficiency has approached that of comparable metal pumps.

Yale & Towne Mfg. Co. showed a new design of rotary pump of variable capacity, adjustable from 0 to 100 g.p.m. at 875 r.p.m. Using a rotating cage and eccentrically supported piston, this pump gives the effect of four cylinders and has practically pulsationless flow. The eccentricity of the piston is readily adjusted.

Schutte & Koerting Co. showed a new diaphragm pump which is being offered in various materials including Haveg. The pump employs a simple reciprocating diaphragm in conjunction with inlet and outlet valves of the ball type. Other liquid handling devices included spray nozzles, valves and special joints. Spraco, Inc., showed a jewelled misting nozzle having a 0.012 in. orifice drilled through a sapphire and capable of delivering 0.625 lb. of water per hour at a pressure of 60 lb. Among the valves, two shown by the William Powell Co. had interesting new features. One type was a line of mechanical-lift plug valves, non-lubricated, available in ordinary and special alloys and adapted to handling a wide variety of liquid and gaseous media. Employing a yoke to dissociate the plug-lifting mechanism from the stuffing box, this valve resembles a gate valve more closely than a plug type. Before the valve is turned, the plug is lifted slightly, whereupon, in its new position, it is again locked. The other valve developed by this company is of the renewable-disk type with non-turning stem.

### Special Valve Materials

New materials for the Saunders valve (originally introduced by Hills-McCanna) were in evidence. This valve, it will be recalled, is of the diaphragm

type. The Haveg Corp. showed one, and others were exhibited in stoneware by General Ceramics Co. and U. S. Stoneware Co. General Ceramics also showed a new stoneware plug valve of the non-lubricated type which employs a special cam mechanism that automatically lifts and releases the plug whenever it is turned.

Another new diaphragm valve, based on its own design, was shown by T. Shriver & Co. This valve is built in both straight-way and relief types and supports its rubber diaphragm mechanically at every position from full open to tight closed.

Corning Glass Works exhibited what is probably the first all-glass valve. It is made of Pyrex brand glass, with a glass plug, glass stem and glass seat within a glass body with bottom inlet and side discharge. It is said to withstand 60 lb. pressure. The stem is of the non-rotating type, operated through a stuffing-box by a metal hand-wheel. This same company also showed ball-check valves made entirely of Pyrex brand glass.

Also for liquid handling is an improved pipe joint shown by Haveg. Grooves are cut near the ends of two abutting pipes which are separated by a gasket. When two sections of a half-round ring are placed in each groove and then held together with flanges, bolts between the flanges may be used to produce a joint that is tight against a higher pressure than that for which the pipe-line is recommended.

### Magnetic Separation Carries On

In the field of magnetic separation there was a very convincing demonstration of the efficacy of recently developed dia-magnetic separators. The machine shown was that made by the Exolon Co. The improved Johnson separator on exhibition was stated to employ only one-twentieth of the power formally required. This is accomplished by numerous refinements in design including air-cooling of the magnet and an improved bearing for the rotor.

Robinson Mfg. Co. showed a new spout-type separator for solid materials. This is produced in 8, 10 and 12 in. sizes and operates so as to retain magnetic particles on the bottom of the trough as the material flows through. Periodically, when the current is cut off, an automatic deflector comes into play, routing the released magnetic particles to a separate chute.

Among the several pieces of reaction equipment shown was the new Blaw-Knox contactor which is a device for intimately mixing or contacting a gas and liquid. Originally developed to wash very fine dust from natural gas, the contactor was later applied as a de-superheater and is now being used for general chemical problems requiring one, two or three stages of contact. The principle employed is a very novel one. The gas is caused to sweep downward over a liquid surface and then up through one or more tubes, the bottom ends of which are situated a short distance above the liquid surface. The result of this action is to produce a vortex or water spout within the tube and to yield a highly turbulent mixture of gas and liquid within the space above the tube. One or more stages of separation, employing vane-type centrifugal separators, are placed in the upper part of the apparatus to separate the liquid and return it to the bottom reservoir.

Swenson Evaporator Co. pointed to a number of refinements in the design of its evaporators and stressed particularly a recent advance that has been made in vacuum crystallization. An important new feature is the use of two to four impellers placed near the bottom of the vacuum chamber so as to produce a swirling action of the contents. The vortex formed carries all solids to the center from which they are readily withdrawn at the bottom outlet, without danger of deposition on the walls.

Many other developments cannot be so readily classified as those discussed above. In power transmission, it was noted that V-belt drives are much more numerous than heretofore. The same may be said of splash-proof motors and explosion-proof motors, particularly those using broad-flange construction.

For the handling of industrial dusts of all kinds, the Pangborn Corp. showed a recently developed all-metal collector designed for ready replacement of the filter cloths. A new type high-speed rapping mechanism is used.

Several of the colloid mills shown by the Premier Mill Corp. incorporated improvements in design including a new means of adjusting the rotor clearance. Manton-Gaulin Mfg. Co. exhibited an improved design of homogenizer. The new machine is easier to clean, stronger and more compact. All parts are readily accessible, yet no moving parts are exposed.

The influence of Repeal was clearly evident in a number of exhibits. New bottle fillers were shown by the Vol-U-Meter Co., by the Alsop Engineering Co., by Karl Kiefer Machine Co. The first of these had a simplified drum cleaner, and the last a new rotary bottle cleaning machine. Edward Ermold Co. showed new labeling equipment. F. J. Stokes Machine Co. demonstrated a new clipless closure machine for products packaged in tubes, as well as a new heavy-duty preform press of 6 tons capacity for preforming molding materials and also for making large sized tablets in pharmaceutical plants.

Among the other miscellaneous items which should be mentioned is a new infra-red filtering glass developed by Corning Glass Works. This material, known as Aklo, cuts out some 65 per cent of the infra red but sacrifices only 15 to 20 per cent of the visible light. This glass, now produced in polished sheets, is available for all applications where a heat-insulating glass is desired.

### Prestressing Concrete for Strength

A novel type of concrete construction was exemplified in the Hewitt prestressed concrete tank shown by the Stebbins Engineering Co. This tank is built by pouring concrete within forms in which asphalt-coated stressing rods are suspended. After the concrete has set, compression is applied to the wall by tightening nuts on the ends of these rods. The next operation is to tighten continuous hoops around the tank to the desired stress. The tank is then finished by applying a coat of unstressed concrete outside the hoops. Bottoms are made with radial reinforcing and linings are generally of acid-proof stoneware. The dome covers are built on a beam principle and attached to the body by the stressing rods. The design has been used for boiling tanks in the pulp and paper industry and at lower temperatures, is suitable for pressures as high as 5 lb. per sq.in. in a 30 ft. diameter tank. Water tanks as large as 120 ft. in diameter have been built.

New developments in other materials of construction were not numerous. Some of the most interesting are those brought out by the Fansteel Products Co. in the production and fabrication of tantalum. This company is now actively engaged in the fabrication of its products, having developed reliable methods for roll and arc welding. The latter, it is interesting to note is conducted under carbon tetrachloride, using the carbon arc. This is necessary to avoid oxidation.

This company is now putting out a complete line of tantalum tubing with and without reinforcing. A reinforced tube of 0.010 in. wall thickness, reinforced internally with a tantalum coil spring, is said to be capable of withstanding 150 lb. steam pressure on the outside. The tubing is produced in various gages and diameters, both straight and coiled.

These improved fabrication methods have come about partly as a result of improved methods in producing the metal itself. The company has developed better rolling, drawing and swedging methods and has learned to control crystal structure. In the matter of hardness, it is stated that this characteristic can now be controlled anywhere in the range from 90 to 600 Brinell.

# NEW EQUIPMENT

## Electric Thermometer Controller

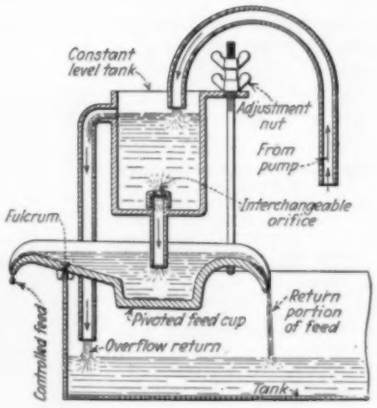
Whereas recording temperature controllers in the thermometer range have ordinarily employed a fluid pilot system or open electric contacts, a new automatic control thermometer announced by the Brown Instrument Co., Philadelphia, Pa., follows the method employed in certain thermoelectric pyrometers in that it uses mercury switches which are positioned by the clock motor. Every 6 seconds a motor-driven control table determines the location of the pen on the chart in reference to the control setting and tilts the mercury switch from one side to the other if the temperature is changed. Consequently, the measuring mechanism is free to position itself, unhampered by the control mechanism.

The mercury switches carry up to 50 amp. at 110 volt and are provided for one-, two- and three-contact systems. The controllers are also available as time-cycle instruments. The same method is employed in pressure and liquid-level controllers made by this company.

## Liquid Reagent Feeder

Extremely accurate feeding of liquid reagents is the function of a feeder developed by the Coulson Engineering Service, Wallace, Idaho. It has been in use in the mining industry for a number of years and is being introduced now for the first time into chemical manufacture.

This device is made in a number of types, but the one illustrated herewith is perhaps the most readily explained. Reagent is placed in a tank from which it is delivered by a small centrifugal pump to a constant-level tank in which the level is controlled by an overflow. The discharge from this constant level tank is through an orifice capable of passing a greater quantity than it is desired to feed. From the orifice the flow is into a tiltable feed cup provided with overflow spouts at both ends. By adjusting the height of the right-hand spout, the amount of reagent recirculated is accurately controlled and the amount discharged to the process is said to remain constant at any desired quantity between 2 to 5 drops and 750 cc. per minute. In another type which works similarly, the feed cup is closed instead of open, to avoid contamination or the danger of oxidizing the liquid. In still another type, an air-lift is employed instead of the motor and centrifugal pump.



**Cross-section of Coulson feeder**

Among advantages claimed for the feeder are its constancy, its ease of adjustment, the steadiness of the feed, and the simplicity and freedom from operating troubles of the equipment.

## Equipment Briefs

Crane Co., Chicago, is marketing a newly designed line of high pressure needle valves made from carbon steel or a high-chrome stainless iron. The valves are intended particularly for use in connection with high-pressure gages and flowmeters. They feature such practical improvements as extra long pipe threads and stem threads and unusually deep stuffing boxes.

For use where it is desired to maintain automatically a constant oil level in ring-oiled and anti-friction bearings suitable for oil-bath lubrication, the Lunkenheimer Co., Cincinnati, Ohio, has developed the Alvor constant-level oil control as one of this company's line of bottle oilers. The design is such that oil can flow from the bottle only when the level in the bearing reservoir drops low enough to permit air to enter the bottle.

For controlling motors which can be started on full voltage, the General Electric Co., Schenectady, N. Y., has introduced the new CR-7006 oil-immersed magnetic switch for use in Class 1, Group D corrosive atmospheres. This is a standard magnetic switch with special coils and special contact tips for operation under oil. The three sizes available cover the range from 3 hp. at 110 volts to 50 hp. at 600 volts.

A distinctly novel type of electric muffle furnace appears in the new Bluehead Type MP furnace developed by the Cooley Electric Furnace Co., Long Island City, N. Y. A principal feature is the Doreco heating element consisting of a nickel-chromium resistor imbedded in a dense, hydraulically compressed block of insulating material having a heat conductivity approximately that of steel and an electrical resistivity about that of porcelain. The effect of using this element, it is said, is to have a furnace chamber with refractory walls, every portion of which is radiating heat evenly and without localized hot spots.

American Instrument Co., Washington, D. C., has announced a new sealed-type mercury thermoregulator for temperature control within 0.02 deg. C., an important feature of which is the ease and accuracy with which it may be set. For use with this instrument, the company has a new supersensitive relay capable of carrying 10 amp. at 110 volts. It is built in three different models.

Life of glass tanks and pots may be extended, according to the Ceramic Division of the Baltimore Paint & Color Works, Baltimore, Md., through the use of a new product, Relinus, which is brushed on and dries overnight. It is said to lengthen the life of the tanks materially and to produce clearer, more brilliant glass.

Rubber-lined drums of 15 gal. capacity for the handling of many corrosive substances have been put on the market by the Chemical Container Co., San Francisco, Calif. The one-piece lining is of molded rubber and the drum is provided with a reversible rubber pouring spout which prevents spilling on the outside of the drum.

For draft and pressure in the range between 0.1 and 100 in. W.G., the Hays Corp., Michigan City, Ind., has announced a complete line of compact electric-contact gages. These employ this company's dry-type actuating unit and are built for either high or low contact service or for both. Both mercury and open-contact switches are available.

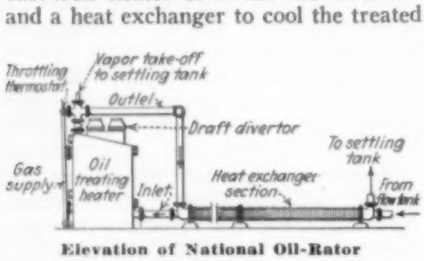
Superior accuracy, convenience and construction are said to be incorporated in a line of certified hydrometers introduced by the C. J. Tagliabue Mfg. Co., Brooklyn, N. Y. They employ solid

metal ballast inside a stream-lined tip and a metal scale for temperature. The thermometer is said to have an accuracy of ± 0.25 deg. F.

Duriron, Durichlor, Durimet, 18-8 steels, Alcumite and chemical lead alloys are available materials for a new line of centrifugal pumps, the smallest ever built by the Duriron Co., Dayton, Ohio. These pumps are of 1 in. suction and discharge with a capacity of 2½ g.p.m. at 25 ft. head. Both belt- and direct-motor-driven models are available.

## Oil Emulsion Dehydrator

For breaking oil emulsions, National Radiator Corp., Johnstown, Pa., has recently developed the Oil-Rator, an equipment comprising in combination a cast-iron heater to break the emulsion and a heat exchanger to cool the treated



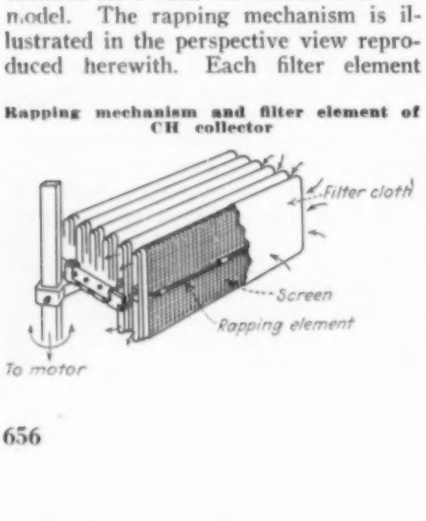

**Elevation of National Oil-Rator**

oil and so to avoid evaporation loss while, incidentally, it preheats the emulsion to be heated. The new equipment maintains the temperature of the oil thermostatically, using waste gas as a fuel. Through their sectional construction, both heater and exchanger may readily be increased or decreased in size. All heat-transfer surfaces subject to fouling are readily accessible for cleaning. Experimental equipment is said to have been operated both in the laboratory and in the oilfields with successful results.

## All-Metal Dust Collector

Moving parts are placed entirely on the clean-air side in the new all-metal, Model CH, dust collector recently announced by the Pangborn Corp., Hagerstown, Md. A number of new features have been introduced with this model. The rapping mechanism is illustrated in the perspective view reproduced herewith. Each filter element

**Rapping mechanism and filter element of CH collector**




consists of a metal and wire frame covered with filter cloth through which the air passes from outside to inside. Dust deposited on the surface is discharged by means of high speed rapping elements which are caused to oscillate at about 1,200 beats per minute by means of rocker shafts driven from a V-belt drive and motor. Among the advantages claimed for the new collector are its all-steel construction, easy removal of frames without disturbing adjacent frames or rapping mechanism, large capacity in proportion to the space occupied, and location of all moving parts in clean air.

## Stiffness Tester

For testing the pliability of such thin materials as paper, metal sheets, imitation leathers and metal foils, Smith-Taber, North Tonawanda, N. Y., has developed the Model E precision stiffness tester. The instrument is used in determining the elastic or spring-like properties of materials, giving a definite rating to each. Furthermore, the instrument may be used in testing the same specimen repeatedly to show the effect of plastic flow in reducing the initial stiffness to a reading of basic stiffness.

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**Tank Construction's Century of Progress**

Arc-welded tanks recently built for the Empire Refining Co., Ponca City, Okla. Two storage tanks appear in the left foreground and in the center, a Hortonsphere built by the Chicago Bridge & Iron Works. Lincoln Electric shielded arc welding was employed.

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## MANUFACTURERS' LATEST PUBLICATIONS

**Aeration.** Norton Co., Worcester, Mass. —Bulletin 2—Article on the cleaning of porous plates and tubes in sewage-disposal plants.

**Apparatus.** Bausch & Lomb Optical Co., Rochester, N. Y.—Leaflet describing constant temperature control equipment for use with refractometers and hydrogen-ion colorimeters.

**Apparatus.** Hevi-Duty Electric Co., Milwaukee, Wis.—Bulletin HD-1133—Folder briefly describing this company's improved excess-temperature cut-out instrument for use with all types of heating equipment.

**Apparatus.** Podbielniak Industrial Research & Analytical Laboratories, P. O. Box 567, Tulsa, Okla.—Circular 9—Describes standardized models of this company's apparatus for low- and high-temperature fractionation analysis.

**Distillation.** The Lummus Co., 50 Church St., New York City—20-page book describing this company's service to the distillation industries in the design and production of equipment and accessories and the building of plants.

**Equipment.** Haveg Corp., Newark, Del.—29 pages describing the construction and use of this company's corrosion-resistant chemical equipment and acid-proof cement.

**Fabrication.** Aluminum Co. of America, Pittsburgh, Pa.—Forms AD 3 and 5—Respectively 26 and 42 pages on the riveting and the welding of aluminum. The latter gives considerable information on all applicable forms of welding.

**Filters.** T. Shriver & Co., Harrison, N. J. —50-page loose-leaf general catalog on this company's filter presses, diaphragm pumps, parts and accessories; describes the selection of presses, types of plate and specific equipment.

**Heating Units.** Harold E. Trent Co., 618 North 54th St., Philadelphia, Pa.—Leaflet TB-30—Price list and description on cartridge-type electric heating units.

**Instruments.** Cambridge Instrument Co., 45 Grosvenor Pl., London, S.W.1, England —6-page folder describing recording and indicating thermometers.

**Materials Handling.** Cleveland Tramrail Division, Cleveland Crane & Engineering Co., Wickliffe, Ohio—Form G-133—6 pages illustrating the use of this company's tramrail systems.

**Metals and Alloys.** Ludlum Steel Co., Watervliet, N. Y.—2 pages of data on this company's Silcrome corrosion and heat-resisting steels.

**Metals and Alloys.** The Superheater Co., 60 East 42d St., New York City—Bulletin B-1—Describes this company's services in the production of castings of standard bronzes, special bronzes and acid resisting bronzes.

**Power Transmission.** Link-Belt Co., 910 South Michigan Ave., Chicago, Ill.—Illustrated catalog describing, with price list, three types of flexible shaft couplings.

**Refractories.** Harbison-Walker Refractories Co., Pittsburgh, Pa.—4 pages describing this company's high-temperature bonding material, Harwaco Bond, for application at temperatures up to 3,000 deg. F. and over.

**Tubing.** Babcock & Wilcox Tube Co., Beaver Falls, Pa.—Bulletin T-7—12 pages describing the processes for the production of and the application of Diescherized pipe and tubing made by this company.

**Uniform Cost.** Metropolitan Life Insurance Co., Policyholders Service Bureau, 1 Madison Ave., New York City—50-page study of uniform cost activities in trade and industry, based on activities of some 75 trade associations with a digest of individual experiences and opinions and information on administration of uniform cost activities.

**Valves.** Edward Valve & Mfg. Co., East Chicago, Ind.—Catalog 11, Section C—Covers cast-steel valves in globe and angle-stop, check and feed-line stop-check designs.

**Weight Recording.** Streeter-Amet Co., 4101 Ravenswood Ave., Chicago, Ill.—Catalog 1.32—12-page booklet describing this company's automatic weight-recording mechanism for attachment to existing scales.

**Welding.** Hobart Bros. Co., Troy, Ohio —Bulletin D-7—12 pages on the arc-welding of ordinary copper by this company's "long-arc" method.

# PLANT NOTEBOOK

## Simplifying Dilution Calculation In Plant Operation

**By George S. Santmyers**
*Santmyers Chemical Co.*
*Pittsburgh, Pa.*

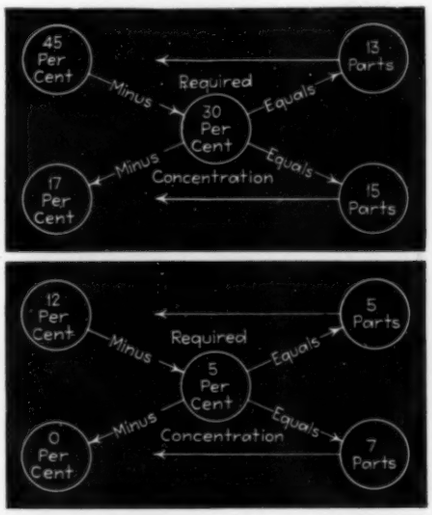
IN PLANT and laboratory work, a rapid and reliable method of calculating dilutions and solution concentrations is much to be desired. The method recommended here is not a new one, but it is known to so few people that it seems worth while to present it again. Additional information on the use and theory of the method, which is known as Pearson's Square, may be found in *Canning Age*, April, 1929, page 364; and in Olsen's Chemical Annual, 1926, page 819. By means of the square, calculations are so simplified that the device is readily adapted to plant use by operators who are not thoroughly familiar with mathematics. For this purpose, the square design may be painted on a blackboard with space for the figures left blank so that the figures for each particular batch or run may be put in with chalk.

Four types of calculation may be performed by the square method. These are illustrated below by percentage volume examples. Calculations for percentage weight and for the dilution or mixing of different concentrations of standard solutions are identical to the given examples.

*Example 1:* It is desired to mix two similar solutions of different concentration so as to produce a mixture of a particular concentration but of indefinite quantity. Let the concentrations of the two solutions be 17 and 45 per cent respectively, and the desired concentration, 30 per cent. It is first necessary to draw up a square or oblong similar to Fig. 1; or this may be a blackboard which has previously been marked off according to the figure. The initial percentage concentrations are then written in the circles at the left and the desired concentration in the center circle. Subtractions are made along the two diagonals and the results set down in the circles at the right. In Fig. 1, for example, these results are $30 - 17 = 13$ and $45 - 30 = 15$ parts. The answer to the problem, following the instructions of the horizontal arrows, is: 15 parts of the 17 per cent solution, plus 13 parts of the 45 per cent solution, will yield 28 parts (neglecting any volume contraction) of 30 per cent solution.

*Example 2:* More frequently it will be necessary to use a definite volume of one constituent, or to produce a definite volume of the mixture, the latter as in Example (3). In such cases, the operator will have to be taught a little simple proportion. Suppose that it is desired to use 300 gal. of the 17 per cent solution of the above example. By means of the square it is determined that 15 parts of the 17 per cent solution will be needed. Then $300 \div 15 = 20$, which is the factor by which the 13 parts of 45 per cent solution must be multiplied to give the required $13 \times 20 = 260$ gal. of 45 per cent solution.

*Example 3:* When a definite volume of finished solution (for instance, 140 gal.) is desired, the square is again used to determine that 28 parts of product will result from the proper mixing. Hence, each constituent will have to be taken $140 \div 28 = 5$ times, or the mixing will require $15 \times 5 = 75$ gal.




**Pearson's Square used in the solution of dilution problems: Fig. 1, Above, where different concentrations of similar solutions are used; Fig. 2, Below, where a solution is mixed with pure solvent**

of the 17 per cent solution, plus $13 \times 5 = 65$ gal. of the 45 per cent solution.

*Example 4:* Still another type of calculation enters when one of the constituents is to be pure solvent. For example, it is desired to mix a 12 per cent solution with pure solvent, to yield a solution of 5 per cent concentration. The problem is set up on the square exactly as in the earlier cases, except that the figure for the pure solvent constituent is zero, as in Fig. 2. By subtraction, it appears that 5 parts of the 12 per cent solution, plus 7 parts of the pure solvent, will yield a solution of 5 per cent concentration. And again, as in Examples (2) and (3), the results may be calculated to the conditions where a definite volume of the 12 per cent solution is to be used, or a definite volume of 5 per cent solution produced.

## Concrete Savings Effected By Instrumentation

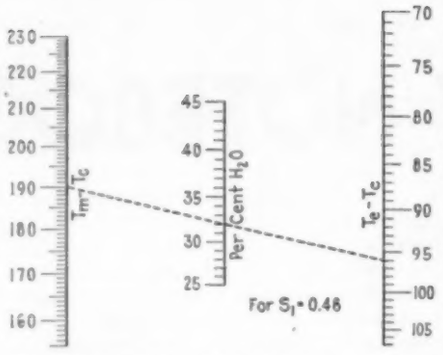
IN A RECENT ISSUE of *Factory Management and Maintenance*, G. A. VanBrunt presents the results of a survey of savings that are being effected through the use of recording and control instruments. A number of examples are taken from plants in the process field and are given below.

A Southern paper mill is saving $13,000 per year through the use of recording thermometers and pressure gages, with improvement in quality and reduction in the fuel consumption. The most important saving is in the tannic acid plant, where closer temperature control has considerably increased the extraction from the chips. In a Southern plant making wood fiber building materials, closer control of time and pressure has prevented a waste of steam and insured uniformity of the product. It was possible to increase the production of the machines involved by 20 per cent. In still another Southern paper mill, a meter for recording steam and air flow, flue gas temperature and furnace draft in the boiler plant produced savings in fuel at the rate of $24,000 yearly.

Many important savings can be made in process power plants. In the handling of coal in one chemical plant, a check on the labor crew by means of two recording wattmeters revealed that the motors were being operated inefficiently and led to savings of over $2,400 per year. In a Middlewestern soap factory, the four boilers were found insufficient and a fifth was to be installed. However, when steam flowmeters had been put in it was possible to make such changes in the firing methods that the installation of the new boiler was avoided, with a saving of several thousand dollars.

Temperature control equipment has

paid high dividends in certain cases. One Eastern chemical plant saved $650 per year in steam through the installation of control apparatus on a single unit of equipment. A recording and control pyrometer on an oil-fired furnace in an enameling plant saved more than $2,600 annually in fuel and made it possible to handle more pieces per heat. In a wire-enameling installation, the use of temperature controllers on the annealing furnaces reduced rejects from 7 to 2 per cent and yielded a saving of 76 per cent per year on the new investment.




**Typical chart for determining water concentration in asphalt emulsions by temperatures of ingredients**

## Using Process Temperatures in Concentration Determination


**By O. F. Neitzke**
*Research Director, Bennett, Inc.*
*Cambridge, Mass.*


IN AN EMULSIFICATION PROCESS where the material to be emulsified is fed simultaneously with the emulsifying liquor into a dispersion machine and the emulsion is run directly into drums for shipment, it is important that the operator have some method of determining that the proper ratio of the entering ingredients is being maintained. When the entering ingredients differ in temperature, it is possible quickly to check this ratio by means of the temperatures, with the aid of an alignment chart. The basis of the method is the formula showing the heat-exchange relations in the process:

$C(T_e - T_c)S_c = (100 - C)(T_m - T_c)S_m$

where $C$ = per cent of emulsifying liquor in finished emulsion; $T_c$ = temperature of emulsifying liquor; $T_m$ = temperature of material being emulsified; $T_e$ = temperature of emulsion leaving process; $S_c$ = specific heat of emulsifying liquor; $S_m$ = specific heat of material being emulsified; and $S_1 = S_m/S_c$.

The equation merely states that the heat lost or gained by the emulsifying liquor is equal to the heat gained or lost by the material being emulsified. $S_1$ may be determined for a given emulsion by taking a sample of emulsion at a known set of process temperatures and analyzing for concentration. An alignment chart can then be constructed, from which the concentration of the emulsion may be determined quickly while the emulsion is being made.

A sample alignment chart is shown in the figure. This chart is suited for the determination of the water content of asphalt emulsions such as are used for road construction work. $S_1$ for these asphalts was found to be 0.48. The process consists of flowing melted asphalt at a temperature of about 300 deg. F., together with a dilute soap solution at about 100-125 deg., into a dispersion machine which effects emulsification by rapid agitation. The resulting emulsion, at a temperature of about 190 degrees, is discharged directly into drums or tank trucks. In the example shown on the chart by the dotted line the asphalt temperature was 290 deg., soap solution temperature 100 deg., and emulsion temperature 196 deg. The emulsion evidently contained 32 per cent of water.

This method of determining concentrations is of course only readily applicable to processes where no artificial heating or cooling is used and where no large heats of reaction or latent heats are involved. This is usually the case in the emulsification of hydrocarbon waxes, oils, or bitumens, by means of dilute aqueous solutions. The described method of determining $S_1$ has the advantage of automatically correcting the formula for the small heat loss to the surroundings by radiation.

## Welding to Rebuild Worn Parts

(Condensed from a larger chart appearing in *Oxy-Acetylene Tips*, Nov., 1933)

| | Operation | Purpose Behind Operation | Metals to Which Operation Is Applied | Type of Surface Resulting |
|---|---|---|---|---|
| 1 | Bronze-surfacing with a rod such as the one of new wear-resisting bronze rods | for building up worn surfaces; low-melting-point rod for ease of application and easy machining; for wearing surfaces in lubricated places or non-lubricated places where low heat prevails | Cast iron, alloy and semi-steel, carbon steels, alloy steels, malleable iron, wrought iron, copper-base alloys, Monel metal, nickel | Surface can be easily machined to close tolerance |
| 2 | Resurfacing with rod of same composition as base metal or very similar | To restore part to original condition and size | All metals ordinarily fusion-welded, and heat-treated alloys that can be given subsequent heat-treatment to restore original physical properties | Can be machined with same facility as base metal |
| 3 | Resurfacing with rod similar to but not same as base metal, such as an alloy steel rod with air-hardening properties | To restore a worn part to original size and give a deposit that may be subsequently forged, heat-treated, or left as welded in a condition superior to original in hardness and toughness | Carbon steels, wrought iron, low alloy steels. Note: Should not be applied to heat-treated steels except in special cases. | Usually not easily machined, but can be easily ground, forged or heat-treated. |
| 4 | Hard-surfacing with iron-base wear-resistant alloys (chromium-manganese-iron alloys such as Haschrome) | For parts subjected to moderate abrasive wear or severe impact; have greater hardness and wear resistance than (3) and are often used as filling or base materials under the more wear-resistant nonferrous alloys (5) (6) | Carbon steels, low-alloy steels though in some cases heat-treatment after application may be necessary; alloy and semi-steel castings; gray cast iron | Can be ground to close tolerance; can be forged or heat-treated if necessary |
| 5 | Hard-surfacing with non-ferrous, wear-resistant alloys (cobalt-chromium-tungsten alloy, e.g., Stellite) | For resistance to severe abrasion and especially for resistance to abrasion at elevated temperatures as the hardness of these alloys is retained at a red heat | Same as (4); also Monel metal and high-chromium (stainless) steels | Grinding finish to very close tolerance; no forging possible and unaffected by heat-treatment; cannot be machined |
| 6 | Hard-setting and hard-surfacing with diamond substitutes (inserts of tungsten carbide) or a composite rod consisting of crushed particles of tungsten-carbide in a bonding material | For parts subjected to extremely severe abrasion | Carbon steels (heat-treatment often necessary); low-alloy steels (heat-treatment often necessary); alloy, semi-steel, gray iron castings | Surface used as originally applied |

# NEWS OF THE INDUSTRY

**What is expected to be the final draft of the Chemical Code has been sent to manufacturers and will be rushed for governmental approval. Tennessee Valley Authority plans complete fertilizer plant. A.I.Ch.E. elects A. E. Marshall president for coming year and S.O.C.M.A. re-elects August Merz. Mathieson Alkali will build new plant in Louisiana.**

## Heat Transfer Center of A.S.M.E. Interest

OCCURRING during Chemical Exposition week, Dec. 4-8, the fifty-fourth annual meeting of the American Society Mechanical Engineers was an added attraction for many of the chemical engineers who were in New York to attend the show. A group of 13 papers on heat transfer, given under the auspices of the Process Industries Committee, A.S.M.E., initiated a series on this subject which it is intended to carry on for a period of years, covering all industrially important phases of heat transfer from a practical and factual standpoint, rather than from the theoretical. Also initiated during this week was a series of 20 weekly lectures on chemical engineering, sponsored jointly by the Process Industries Committee and the American Institute of Chemical Engineers and held under the direct supervision of Dean W. T. Read of Rutgers and Profs. H. J. Masson and A. B. Newman of New York University and Cooper Union, respectively.

Among the papers on heat transfer was one by M. B. Higgin in which he presented a table of 25 tests of refinery heat exchangers, specifying conditions and listing the resulting coefficients. P. H. Hardie and W. H. Cooper described experiments to check an earlier developed method for expressing the effect of fouling in heat exchangers. E. R. Binkley discussed the effect of the angle of emission on the radiating power of various oxidized metal surfaces. W. T. Moore presented a paper on heat transfer in mercury systems, explaining that the use of mercury for this purpose is practically limited to the saturated vapor. He pointed out some of the difficulties attendant on mercury use. Despite difficulties, boilers have been operated with heat absorption rates as high as 90,000 B.t.u. per hour over a vertical tube of 3.5 to 4 sq. ft. of surface. The paper gives coefficients of heat transfer.

Other papers in this symposium covered application of fouling factors, transfer in pipe stills, transfer rates in electric and fuel-fired furnaces, transfer in iron and steel plants in metal quenching and in air heating, air conditioning and in refrigeration.

Papers offered at the session of the Process Industries Committee included one by Victor Buhr concerning opportunities for chemical and mechanical engineers in the brewing industry. As Mr. Buhr remarked, the brewmaster is necessarily king, but this does not reduce the great opportunity that exists for many sorts of improvement that the engineer can introduce. A second Process Industries paper was that of C. W. Thomas and Arnold Weisselberg on the fundamentals of drying methods. This paper presented a plan for the standardization of drying terms and offered a classification to be used as a basis for codifying practice in this important unit operation.

Many other papers were of greater or lesser interest to chemical engineers, including a symposium dealing with the creep of metals at high temperatures. Another group was concerned with boiler water, and still another with discharge coefficients for sharp edged orifices, and for orifices used with viscous liquids.

## Italian Government Forms Sales Bureau for Sulphur

IN A report from Rome made by trade commissioner Elizabeth Humes, it is stated that following the dissolution of the Sicilian Sulphur Consortium in July, 1932, an unsuccessful attempt was made to form a national sulphur consortium which would control the output of Montecatini on the mainland as well as Sicilian production. It is alleged that producers, released from quota restrictions and faced with the necessity of reducing their production costs, got out more sulphur during 1932-33 than had been mined in Sicily in years. The output has been estimated as high as 280,000 to 290,000 tons. With the aid of the fund put at the disposal of the Consortium by the government, stocks of the Consortium were moved rapidly and now probably do not exceed 50,000 tons.

Up to the spring the Sicilian producers were able to meet world market prices, if not at a profit, at least without any serious loss. With the fall of the dollar the situation became critical. Sicilian producers can no longer operate except at a loss and would be obliged to close their mines. Such a step would mean throwing thousands of miners out of work and would seriously disturb the economic balance of the island. Rather than allow this the government has intervened to carry the Sicilian sulphur industry until market conditions again adjust themselves. At the cabinet meeting held Oct. 14, the government took advantage of the enabling act of Dec. 20, 1932, and announced that a Central Sulphur Sales Bureau would be formed to market Italian sulphur, both Sicilian and mainland production, on the domestic market and for export. The government also will subsidize the industry to the extent necessary to bridge the gap between Italian production costs and world market prices. At the same time there will be a reorganization and supervision of the industry with a view to readjusting mining royalties, taxes, etc., and taking every means of bringing down production costs.

# NEWS FROM ABROAD

*By Special Correspondents of Chem. & Met. at London, Berlin and Paris*

## London

DURING the last three or four months there has been little of outstanding interest to report, as regards British chemical industries, but your London correspondent during an absence abroad of nearly three months in various parts of Europe, has found a multitude of interesting developments maturing and ready for exploitation. It is, therefore, not out of place to express the view that the coming year may be particularly fruitful and encouraging for similar visits by executives of United States chemical corporations, who have not already made arrangements or representation for regular intelligence and news service. The German chemical industry, in particular, appears to be exceptionally busy and fertile, in spite of the continuance of nationalistic efforts by all smaller countries to establish their own basic industries. The general tendency will probably be for the brains and experience of the more highly organized and developed countries to participate in such local chemical enterprises and developments, particularly where local conditions as regards power, transport, and raw materials are favorable or important.

A very prevalent rumor credits the Hitler government with having instructed the I. G. and others to make Germany independent of imported oil and gasolene, and a plant of an annual capacity of 2,000,000 tons and giving permanent employment to 150,000 appears to be contemplated. Whether the object of this scheme, if correctly reported, is directed mainly to finding employment, or whether the potentially valuable and adequate oil resources of the Hannover district have on further investigation proved unsatisfactory, time only can show. On the other hand there appears no valid foundation for the statement commonly made, that the German chemical industry is mainly busy on account of armament and munition development.

In England the chemical industry is making excellent progress, and is likely to improve still further if the present trend of improved trade and conditions in this country continue. Imperial Chemical Industries, Ltd., has declared an interim dividend of 2½ per cent and several of their subsidiary companies are reported to be doing excellent business. A further development of the plasters marketed by them and made by cold process from their pure anhydrite deposits at Billingham, is foreshadowed, and also the entry of the concern into the plaster board industry next year. Developments in this direction have been much slower than in the United States, and have been mainly handled by British Plaster Boards, Ltd. The rayon industry is doing well, and in the acetate rayon field, particular mention might be made of the Cellulose Acetate Silk Co., whose plant is being rapidly extended, and who are likely to make an excellent showing as regards profit when their annual report is published. By then something further may be heard of the Celanese-Courtauld patent suit which has still to come up for final hearing before the House of Lords. The Metalion process of nickel and chromium plating has proved highly successful, and a new and much larger factory is now under construction near London, which is to embody several new features and improved methods.

The annual report of the Fuel Research Board, just published, is rather an academic document, but some quiet and good work is proceeding in the hydrogenation of tar and coal, cracking of gases, powered fuel combustion and low temperature carbonization. As usual there has been press criticism of the Board's heavy expenditure and poor results and of the meagreness and lateness of publication. Perhaps the most valid criticism is that public money is being used to develop and even patent methods and inventions, some of which in the past have involved serious financial loss, and which, at best, are thought unlikely to give results better than those obtainable by private enterprise if suitably subsidized. The best work done at Greenwich is probably that resulting from the cooperation of private firms and individuals with the Board, and unfortunately that can seldom be published.

Dr. F. H. Carr is the new chairman of the Association of British Chemical Manufacturers, and that body has recently endeavored to put insulin upon the list of fine chemicals subject to import duty. The arguments adduced before the Court make interesting reading, but a decision will not be given for some weeks. The new Food Group of the Society of Chemical Industry is more than active, and the symposium recently held inspires hope of great things to come. There is some danger, however, that the subject group idea may be overdone, and considered applicable in directions for which the Society is not fundamentally equipped. Ultimately, there may be danger of the various groups wagging the Society's tail.

## Berlin

THE favorable development of the business of the I. G. which was evident in the second quarter has continued in the third quarter. Domestically the steps taken by the government for creation of work have had a favorable effect and they have resulted in an increase in production and sale of many products. Among others the gasoline production once more went up, and the part made from lignite is constantly increasing. After the I. G. had succeeded in preventing the discharge of 12,000 men, during the worst period of the depression, by cutting the working week from 48-56 to 40 hr., a new program of creating work through new projects has further taken 34,000 men from the labor market. In addition to this, and to increase the stocks of supplies on hand 40,000,000 Rm. has been appropriated in the budget for this winter (20,000,000 Rm. in 1932). Further favorable news also comes from the potash industry, where work has been started again in several plants that had been closed down.

In the fall meeting of the Society for Mineral Oil Research the report on the Still process by Carl Still G.m.b.H., Recklinghausen attracted much attention. The process depends upon the fact that three different zones may be found in a coke furnace, (1) in the center a zone of non-coked carbon, with a temperature of about 100 deg. C.; (2) the plastic zone, with a temperature of 350-500 deg. C.; (3) the coking zone on the outside, nearest the walls, with a temperature of 900-1,100 deg. C. The advantage of the Still process is, that the valuable distillation products may be drawn undecomposed through the comparatively cold coal during the major part of the coking time. Thus larger quantities of benzol and tar, the latter of improved quality, are obtained. From the top of the retorts, immediately upon filling, 10 to 12 vertical holes are punched in the central portion of the charge, and suction pipes are pushed 300 mm. into the coal through these holes. These suction pipes are connected to a manifold and the manifolds from all retorts are again connected with the receiver for "inner" gas and tar. At the same time a pipe in the cover connected to a second receiver collects the "outer" gas above the coal in the usual manner. This arrangement provides a perfectly safe method of removing from the retort all of the gas, or a certain undecomposed portion of the gas, as economic considerations or marketing conditions may dictate. While the outer tar

like ordinary coal tar, cannot be cracked, the inner tar made in the Still process, which may be obtained to the extent of 60 per cent of the total tar, may be cracked with good results. The procedure depends upon the well-known method of heating under pressure with subsequent expansion of the decomposed products. The sensible heat of the products leaving the cracking apparatus, after expansion in a column is utilized for decomposing the cracking products as well as the inner tar into light hydrocarbon (inner tar cracking gasoline) on the one hand and a normal pitch residue and an intermediate product, so-called circulating oil, on the other hand.

At the coke plant Wolfsbank at Achenbach 5 tons inner tar was treated daily. By the Still method 30-40 per cent more benzol with 10-14 per cent more aliphatic hydrocarbons and 10-20 per cent more tar was produced above the regular coking processes, depending on the nature of the coal. Yearly average is 30-40 per cent more benzol and 10-15 per cent more tar. In cracking the inner tar either inner tar cracking gasoline, gas, and pitch are produced or, depending on market conditions, fuel oil, tar for paving purposes, benzol washing oil, and other special oils. This simple method of adaptation to market conditions is extremely valuable. The proportions obtained by the cracking of the inner tar are, for instance: inner tar cracking gasoline 23 per cent (by weight); gas 8; oil 21.3; pitch 46 per cent, leaving a loss of 1.7 per cent. In addition to the increase in benzol and gasoline recovery the Still process offers still other advantages, such as a 10-15 per cent increase in furnace capacity under otherwise similar operating conditions; a 7-10 per cent saving in heating gas requirement; a marked improvement in the quality of the coke resulting from the changed method of gas removal, especially with poorly backing coals (such as coal from upper Silesia, Saxony, and the Saar District). Summarizing it may be said that depending upon the nature of the coal 4-9 tons per 1,000 tons dry coal, or 60-75 per cent more benzol and gasoline may be obtained than by the usual methods. On the other hand it was stated that depreciation and interest in the Still process would have to be taken care of in 2-3 years, as the capital investment is about 1,300-1,600 Rm. per ton of coal treated.

"Compressed gas has now been brought on the market by Erdol-Raffiniari A.G. (Denrog), in Hannover. This firm is utilizing fairly pure propane obtained as byproduct in cracking for this purpose. One kilogram of propane gives 12,000 calories and requires only 2.35 liters of cylinder volume and 1.5 kg. cylinder weight.

Ruhrchemie A.G. produces hydrocarbons containing chlorine by thermal treatment of methane or by heating methane in the electric arc. The resulting gas mixture contains about 12 per cent acetylene, of which 90 per cent may be converted into tetra-chlor-ethane. These chlorine compounds have many uses. Trichlor ethylene, for instance, in addition to its use as solvent is also employed in the so-called Drawinol process for production of absolute alcohol by azeotropic distillation. Viscous synthetic resins similar to japan lacquers may be obtained, according to Prof. Joh. Scheiber of Leipzig, by heating uni- or polyvalent phenols (phenol, cresol, resorcin, naphthol and similar products) with unsaturated high-molecular fatty acids or their mixtures (oleic acid, linoleic acid, linolenic acid) in the presence of metal chlorides, for instance, zinc chloride, aluminum chloride, and others, whereby the unsaturated part enters into the aromatic nucleus. This process which appears to obviate the involved natural process of making japan lacquer produces materials of high solubility in hydrocarbons, alcohols and esters.

A new cellulose derivative marketed under the names Tylose S and SL by Kalle & Co., Biebrich is used as emulsifying and dispersion agent in the paper industry, and in shoe and leather manufacture. The products are manufactured in pressed cubes and balls of various sizes, and with the same structure as the cellulose. The solutions are obtained with boiling water and have different consistency according to the viscosity selected. They are very resistant to mold, decay, alkalis, and many acids and salts. A special advantage above other emulsifying and dispersing agents is that the synthetic products do not contain any granular particles.

The increase in corrosion resistance of light-metal objects, especially those made of aluminum and magnesium and their alloys, the resistance of which depends upon the formation of an oxide film on the surface may be materially increased, according to investigations by Erft-Werke A-G., Grevenbroich, by exposing these metals to the action of ammonia vapors. An increase in weight of the treated objects is attained at the same time.

## Paris

THE FRENCH chemical industry still maintains a waiting attitude as a result of the political position, with the budget presenting a deficit of 6,000,000,000 fr. and the politicians unwilling to economize; the future relations with Germany likewise is a matter of concern. It should also be noted that the depreciation of the dollar has had some effect on the sale of chemical products, and a new low has lately been observed for the alkalis, sodium carbonate and caustic soda.

The general tendency in most European countries is, on one hand, governmental economic control, and on the other, the attainment of balanced exchange ratio with the various nations as far as possible by rigorous reciprocal arrangements. It is a difficult program to carry out, and if, for example, Japanese imports from France are approximately of the same value as French imports from Japan, the trade balance with Germany, the United States, and Soviet Russia show a deficit, as these countries sell to France much larger quantities of manufactured products (Germany) and raw materials (U.S. and U.S.S.R.) than France exports to them as finished products. As far as the United States is concerned, the French wine industry hopes that after repeal of prohibition, sales of wines may result in a notable improvement in the trade balance, which showed a total of 1,117,000,000 fr. in favor of the United States for the three first months of this year.

In the field of inorganic products a decrease in exports of most products has taken place. It is, however, interesting to observe an increase in the export of some products, such as hyposulphite, which has reached 440 metric tons in 1933 (compared with 135 tons for six months of 1931); this is a result of the activity of Societe Industrielle des Dirioes du Souffre at L'hommelez-Lille (Nord) which specializes in this product and has attained a dominating position.

Here a word may also be said about the progress in the Algerian quicksilver production. The only deposit exploited is that of Ras-el-Ma, where the production has increased from 11.2 tons in 1930 to 42.9 tons in 1932 and 51.2 tons in 1933, all of which was sold in France, with exception of 1.5 tons which was exported. The production does not yet cover French consumption, the annual imports averaging 180 tons for the period 1929 to 1931, but the decrease for 1932 is noticeable, in which year 152 tons was imported, and still more for 1933, when imports for the first six months was only 61 tons. The Spanish-Italian quicksilver cartel has, however, lowered the price to about 70 per cent in the course of 18 months, thus making the exploitation of the Algerian deposits particularly difficult. The interests therefore demand an import duty on quicksilver.

The metal is used principally by the electrical industry and for production of explosives (fulminate). In 1928 France imported 70 tons of mercury salts, mainly oxide and corrosive sublimate, 35 tons of which came from Italy. But the French industries have made progress in the manufacture of these, and the import of mercury salts for the first six months of 1933 fell to 11 tons.

# NEWS FROM WASHINGTON

By PAUL WOOTON

*Washington Correspondent of Chem. & Met.*

CHEMICAL industry under NRA will now deal directly with Charles H. Herty, recently appointed as deputy administrator. This does not supplant General Williams, merely supplements his effort in his enlarged responsibility as a division administrator.

Chemical Alliance code has progressed somewhat during the past month and is now receiving another "final" consideration by the companies which will be affected. Presumably when a sufficient number of acceptance signatures are received, General Johnson will ask Presidential approval of the code.

Alcohol has naturally been the subject of much official attention since the effective date of the repeal of the Eighteenth Amendment. Industrial alcohol, as well as beverages, will be somewhat affected. Most significantly industrial alcohol will be under a new commissioner because of the resignation of James M. Doran, who has served as Commissioner of the Industrial Alcohol Bureau, now to head the alcoholic beverage distillers' Code Authority. The codes now in effect as a temporary measure of federal regulation, necessary with the termination of legal prohibition, are but a stopgap. All will be superseded by legislation expected to have early attention in the next Congress which convenes in January. However, under both the present codes and under prospective legislation, Washington confidently expects continuance of the permit system for industrial alcohol as that system was originally established more than twenty years ago, long antedating the Eighteenth Amendment and the Volstead Law.

### TVA Plans Complete Fertilizer Plant

Tennessee Valley Authority proceeding vigorously on its fertilizer program, has announced that plans are to be drawn for a complete fertilizer plant. Stone and Webster has been engaged to work on these designs. Contracts for actual construction will be arranged later. The more optimistic estimates suggest the beginning of some construction work in January. These new plans do not supplant those announced earlier in *Chem. and Met.* for designs of new phosphoric acid equipment by the engineering staff of Research Corporation. The Stone and Webster project will take account of Research Corporation's designs and deal with the problem in its broader aspects.

The most striking development in Tennessee Valley as affecting process industry is the extremely low industrial power rate which has been established for resale by public-utility companies who buy power wholesale from TVA. Special rates for industrial use begin at 7 mills and reach as low a figure as 2.5 mills per kw.-hr. for large quantity power users.

Taking its own time, the administration apparently has arrived at the point when it is ready to consider questions of foreign trade and the tariff. With the subsequent depreciation of the dollar, it is no longer a question of repairing the tariff wall against off-gold countries but bargaining for reciprocal trade assumes a very practical aspect. Domestic industries individually are not any more willing now than ever to invite foreign competition in order to create or restore the foreign market for another but, with liquor, the administration has a trading point that can't be beat. In view of the tremendous deficiency in domestic supply, the industry which is just getting on its feet again cannot effectively protest against bargains with England, France, Italy, Spain and other countries which would open their markets to foreign and certainly some factory products of the U. S. A. in return for a share of the liquor business.

The administration has no specific authority to negotiate reciprocal trade agreements but there is nothing to prevent George N. Peek, new export trade promoter, from carrying negotiations forward in anticipation of legislation. Such agreements, indeed, may be arrived at, to the extent that they concern liquor, without benefit of legislation as this presumably involves no concession in tariff rates by the United States. President Roosevelt refrained from proposing reciprocal tariff legislation last spring but since he has now turned to the export market to assist the AAA and NRA programs, it is expected that he will do so in January.

### Protection Against Foreign Competition

First among industries to invoke protection against foreign competition by reason of the high cost of flying the Blue Eagle is the Lead Pencil Institute. The Tariff Commission has adopted special rules of procedure for handling such cases. On the tariff as a fundamental proposition, the administration must remain mute because of the additional burden of cost imposed upon industry and agriculture by the recovery program. No more will be heard of the Roosevelt campaign pledge for a reduction in the tariff. There is little that the Roosevelt administration can do, therefore, beyond some international bargaining and any other fruits plucked in the export market will come from the competitive advantage given to American industry by the cheap dollar. Otherwise, the administration has made the choice between two lines of policy, so simply stated recently by Secretary of Agriculture Wallace, either to modify its tariff policy so as to permit a larger quantity and value of imports to enter the country, or accept a considerable and permanent loss of its foreign markets.

Peek's removal and the accession of Chester C. Davis, chief of the Production Division, to the post of AAA administrator, signifies emphasis on production control rather than on price-fixing and marketing in future. Marketing agreements may go by the board and with them the unique document of the gum turpentine and gum rosin producers. As producers and processors, they are in the position of negotiating an agreement with themselves. In this situation, industrial consumers represented by the Bureau of Raw Materials for the Vegetable Oils and Fats Industries proposed that the government should have two members on the producers' control committee with a view to shaping a policy of production curtailment not so drastic as to turn the market remaining to naval stores over to competing products. Never having been in touch with marketing problems, the producers' committee, if left alone to conduct the affairs of the industry, will do their market irreparable injury, according to John B. Gordon, Secretary of the Bureau of Raw Materials.

"If the producers would stop turpentining trees less than nine inches in diameter and cease scarifying larger trees too high from the ground, they will," said Mr. Gordon, "get all the limitation production needed without imposing an arbitrary curb and no reasonably-minded consumer can object."

Sealing of abandoned coal mines in the Ohio river watershed to protect water supplies from contamination by sulphuric acid has been approved by the Civil Works Administration and an allotment of $1,519,750 made to the Public Health Service, which will have charge of the project. The effectiveness of reducing the acidity of drainage water by sealing abandoned mines has been demonstrated by several years of actual field work under the direction of the Pennsylvania and West Virginia Health Departments and the U. S. Bureau of Mines.

## Du Pont Offers to License Use of Duco Patents

AS an aftermath of the DuPont-Glidden litigation over the validity of Duco patents, it is announced that final agreement, out of court, has been reached between the two companies and that the Glidden Co. has been licensed to produce all types of lacquers covered by the DuPont patent. The DuPont company also has offered to license other manufacturers, their offer reading:

"A payment to us of four and one-half cents (4½c.) on each gallon of the compositions used and/or sold by you and your subsidiaries (if any) embodying the invention or inventions of the Flaherty patent from January 2, 1931, up to and including December 31, 1933. This payment will constitute a complete release from past infringement, of the Flaherty patent and the other lacquer patents mentioned in our lacquer license agreement, by you, your subsidiaries (if any), and your customers of such licensed compositions with respect to which royalties are so paid."

"An agreement by you to accept our standard form of lacquer license agreement (with the reference to Hitt Patent 1,710,453 eliminated from Sections 6 and 9 thereof), whereby you agree to pay a royalty of six cents (6c.) per gallon on every gallon of the licensed compositions used and/or sold by you and your subsidiaries (if any) and embodying the invention or inventions of the Flaherty patent, with a minimum license fee of three thousand dollars ($3,000) per year, from January 1, 1934, up to the date of the termination of said license."

## Grain Alcohol Favored for Beverage Use

WHILE the Bureau of Industrial Alcohol ceased to exist on Dec. 5, having become a part of the Bureau of Internal Revenue, the alcohol industry is still under federal regulation as the Attorney-General has ruled that Title III of the Volstead Act governing bonds and permits is still in effect.

The industrial alcohol industry has been placed under the code which will be adopted for the chemical industry. However, it is directly concerned with the marketing agreement which is to supplement the code for distillers. This marketing agreement contains a provision which restricts sales of alcohol for beverage purposes to material made from domestic grains except that 10 per cent of production may be allowed for other raw materials under special permits.

Producers of alcohol who use molasses and sugar as raw materials have entered vigorous protests against this feature of the marketing agreement. These objections, however, appear to have been overruled as reports from Washington state that although producers of alcohol from molasses and products other than grain are voicing vigorous objections to the provisions in the distillers' marketing agreement which restricts the use of their product in the manufacture of alcoholic beverages, the AAA does not contemplate altering present regulations.

## Revised Chemical Code Ready for Approval

The fifth draft of the Code for Fair Competition for the Chemical Manufacturing Industry has been submitted to the various chemical companies for approval and when sufficient signatures have been obtained, speedy governmental approval is anticipated.

Main differences between the code as now drawn up and the original copy—published in August *Chem. & Met.*—are found in Article III where minimum wages for employees are placed at 35c. an hour for the Southern District and 40c. an hour elsewhere. An additional clause also names 20c. an hour as the minimum wage for common labor employed in the potash industry within a radius of 100 miles of Carlsbad, N. M. The number of apprentices and learners in the new draft is restricted so as not to exceed 5 per cent of the total number of employees in any company.

Article VIII of the original copy, dealing with employee organization and bargaining is incorporated unchanged in the revised code but the so-called "merit clause" which was strongly advocated by manufacturers has been expanded in the revised code, Article IX reading in part as follows: "It is recognized that the chemical industry, if it is to keep abreast of chemical progress in the world, requires employees capable of constant advancement in their technical skill and of high and loyal character. Therefore, conscious of the great purpose of the industry, by presenting this code the employers in this industry shall not be deemed to have waived any of their constitutional and legal rights to engage, promote, or release employees, regardless of membership or non-membership in any organization, and the members of the industry shall not be deemed to have waived any other constitutional rights."

## A. I. Ch. E. Selects New York For Spring Meeting

THE fall meeting of the American Institute of Chemical Engineers opened at Roanoke, Va., on Dec. 12 and continued for three days. At the business session it was decided to hold the spring meeting in New York during the week beginning May 14. A committee from the New York section will have charge of arrangements.

Officers elected for the ensuing year are: president, A. E. Marshall; vice-president, Harry A. Curtis; secretary, F. J. Le Maistre; and treasurer, M. H. Ittner. Newly elected directors and members of the Council are: J. R. Withrow, E. L. Wilson, A. G. Peterkin, and G. J. Essellen.

## Mathieson Alkali to Build New Plant in Louisiana

ANNOUNCEMENT has been made by the Mathieson Alkali Works that 1,600 acres of land on the Lake Charles, Louisiana, ship channel have been acquired by the company, and that work will be pushed on the construction of a new $5,000,000 chemical plant.

The contract for the new plant, which will manufacture soda, caustic and ash, and other chemicals, has been placed with Stone & Webster, of Boston, and the work of building will begin at once.

The selection of the site culminated a five-year study. Extensive salt rights have been acquired at the Hackberry (La.) oil field and brine will be carried through a twenty-mile pipe line to the plant.

In conjunction with this announcement The Mathieson Alkali Works will offer 207,761 shares of no-par common stock of the company at $30 a share.

## August Merz Re-Elected President of S.O.C.M.A.

MEMBERS of the Synthetic Organic Chemical Manufacturers Association held their twelfth annual meeting in New York on Dec. 7. The business session included the reading of reports and the election of officers for the ensuing year. Dr. E. H. Killheffer, vice-president of the association, because of ill health, refused to continue in that office, but other officers were re-elected as follows: president: August Merz, Calco Chemical Co.; vice-presidents, E. G. Robinson, E. I. du Pont de Nemours & Co., and F. G. Zinsser, Zinsser & Co.; treasurer, Ralph E. Dorland, Dow Chemical Co.; and secretary, Charles A. Mace.

At a luncheon following the meeting the association was addressed by Francis P. Garvan, C. C. Concannon, and A. Cressy Morrison.

# NAMES IN THE NEWS

J. M. DORAN has resigned from the position of commissioner of the Bureau of Industrial Alcohol to become chief of code authority of the distillers.

PIERRE S. DU PONT, chairman of the board of E. I. du Pont de Nemours & Co., has been appointed head of the National Recovery Administration's Industrial Advisory Board. Another new member of the board is Morris E. Leeds, president of Leeds & Northrup.

FRANK CONRAD, assistant chief engineer of the Westinghouse Electric and Manufacturing Co., has been awarded the John Scott Medal for scientific achievements by the city of Philadelphia.

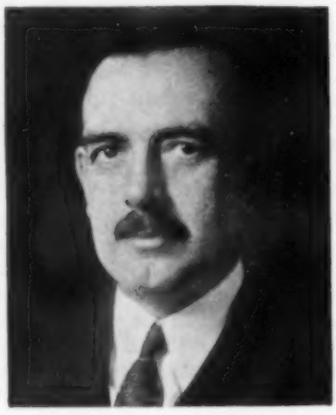
CARL L. ALSBERG, director of the Stamford Food Research Institute, has been appointed by Gen. Hugh Johnson as special member of the Consumers' Advisory Board of NRA. Mr. Alsberg was chief of the Bureau of Chemistry, Department of Agriculture, before his appointment as head of the Stamford food research work.

V. R. KOKATNUR, a consulting chemical engineer of New York City and Bombay, India, is returning to India to represent American firms cultivating commercial and technical relations in that country.

CARL HANER is chief chemist of the Continental Distilling Corp., Philadelphia, and its parent body Publicker Commercial Alcohol Co.

B. H. LINCOLN, assistant to the manager of manufacturing of the Continental Oil Co., has been made chief chemist. Dr. Lincoln graduated from the University of Arkansas in 1923, and in 1926 became chief research chemist of the Continental company of Maine, and in the merger of that company and the Marland Oil Co., he was transferred to the manufacturing department. His promotion follows the recent death of Alfred Henrickson.

L. S. CANNON, chief research chemist of the Continental Oil Co. has been made general control chemist. He is a graduate of the University of Virginia. In 1924 he joined the Marland Oil Co., which was later merged with the Continental company.



**Albert E. Marshall**

A. E. MARSHALL has been honored by the chemical engineers of this country with the presidency of the American Institute of Chemical Engineers. The well-known consultant of New York City joined the Institute in 1915 and has been active in the organization's affairs, serving as chairman of several committees and for the past two years has been vice-president. Before becoming a consultant Mr. Marshall was works manager for the United Alkali Co., manager of Thermal Syndicate Ltd., and works manager for Davison Chemical Co.

J. S. HUME, assistant chief chemist of the Continental Oil Co., has been appointed resident chemist at Ponca City, Okla.

MARTIN H. ITTNER, chief chemist for Colgate-Palmolive-Peet Co., Jersey City, N. J., and Frederic J. LeMaistre, Philadelphia, Pa., have been re-elected treasurer and secretary, respectively, of the American Institute of Chemical Engineers.

JAMES R. WITHROW, professor of chemical engineering at Ohio State University, Gustavus J. Esselen, consulting chemical engineer, and Albert G. Peterkin, development engineer, Atlantic Refining Co. were elected directors and members of the council of the Institute at the annual meeting at Roanoke, Va.

LESTER E. DAY, formerly with the Anglo-Chilean Consolidated Nitrate Corp., Tocopilla, Chile, has become associated with the Carrier Engineering Corp., Elizabeth, N. J.

**Harry A. Curtis**

HARRY A. CURTIS has been elected vice-president of the American Institute of Chemical Engineers. Dr. Curtis is chief chemical engineer for the Tennessee Valley Authority having resigned the position of chief of the research and development laboratories of the Socony-Vacuum Corp. in September to accept the appointment.

N. C. FLINT has been made manager of the mill of the Eddy Paper Co. at Three Rivers, Mich. He succeeded J. H. Conway, who has been acting manager since the death of J. M. Monahan. Mr. Conway has been transferred to the Rockford mill of the company.

GEORGE E. HONEYWELL has joined the chemical laboratory organization of the Upjohn Co., Kalamazoo, Mich.

W. W. ROBINSON, JR., chemist for The Texas Co. has been transferred from Beacon, N. Y., to Long Beach, Calif.

WILLIAM A. KINGMAN has joined the Glyco Products Co., Brooklyn, N. Y., as special sales representative with headquarters at Farmingham, Mass. Formerly, Mr. Kingman was chief chemist for the Dennison Manufacturing Co. and later chemist for the Lowe Paper Co.

R. N. SARGENT, a chemical engineer formerly associated with Roessler & Hasslacher Chemical Co. and American Cyanamid & Chemical Corp. is now plant engineer for the General Chemical Co.

H. C. MOUGEY, assistant technical director and chief chemist of the research laboratory of General Motors, has been appointed A.S.T.M. representative on the Sectional Committee on Specifications and Methods of Test for Safety Glass.

**Charles H. Herty**

CHARLES H. HERTY is one of the recent appointments to the staff of General Johnson, head of the National Recovery Administration. The new deputy administrator has been assigned to Division 3, in charge of codes for the chemical industries. Dr. Herty's long service in the chemical profession and his genial personality make him well qualified to handle the difficult assignments that immediately confront him in his new position in Washington.

LOUIS EHRENFELD has joined the staff of the Wahl-Henius Institute of Chicago, in the capacity of assistant to the director. He has resigned his position with the Museum of Science and Industry.

MARION C. REED has been transferred from the Carbide & Carbon Chemicals Corp. to the research laboratory of the National Carbon Co., Cleveland.

LEON A. SWEET has joined the research organization of Bauer & Black Co., Chicago. Previously he was with the Commercial Solvents Corp.

C. E. HAVER, formerly an engineer with the General Chemical Co., has joined the Chemical Construction Corp., New York City.

CHARLES ROCHE is now a research chemist for Merck & Co., Rahway, N. J. Previously he had been associated with E. I. duPont de Nemours & Co. and American Cyanamid & Chemical Corp.

## OBITUARY

ROBERT E. BUCK, 52 years old, southern manager of the Arnold Hoffman Co., died suddenly at his home in Charlotte, N. C., Dec. 10.

JAMES A. YATES died Nov. 12. Before becoming head of the department of chemistry and physics at Kansas State Teachers College, Dr. Yates was in charge of science at Ottawa University.

JOSEPH L. MAYER, chief chemist of the Louis K. Liggett Co., and head of the chemistry department at the Brooklyn College of Pharmacy, died suddenly Dec. 1, of a heart attack. He was 58 years old. Mr. Mayer had been chief chemist of the company for more than 20 years, before that having been in the same position for the Riker-Hegeman Co.

T. CHALKLEY HATTON, for 13 years chief engineer of the Milwaukee Sewerage Commission, died Nov. 11 as the result of an automobile accident the previous day. He was 73 years old. Mr. Hatton was best known for his pioneering in the activated-sludge process of sewage disposal. After several years of experience in design and construction of systems in the Atlantic Seaboard cities he studied systems in Europe. In 1913 he was appointed chief engineer of the Milwaukee commission and remained in that position until 1927. At that time the plant which he had constructed had been in successful operation for over a year.

SAMUEL R. MORROW, SR., manager of the Birmingham office of the Chain Belt Co., died Oct. 29, when he contracted pneumonia after an apparently successful appendicitis operation earlier in the month.

ALBERT K. CHURCH, chief chemist for the Lever Brothers Co., died Nov. 18 at his home in Cambridge, Mass. He was 63 years old. Mr. Church was graduated from Massachusetts Institute of Technology in 1892, and worked for the National Tube Co. before going with Lever Brothers.

RICHARD B. MELLON died Dec. 1 at his home in Pittsburgh, after a month's illness. He was 75 years old. Among the numerous companies in which he held directorships were the Pittsburgh Plate Glass Co., Aluminum Co. of America, Westinghouse Electric & Manufacturing Co., Koppers Co. and Gulf Oil Corp.

Award of the medal of the American Institute of Chemists for distinguished service to chemistry was made in 1931 to Richard and Andrew Mellon. The distinguished brothers were chosen for the award by the establishment and maintenance of the Mellon Institute of Industrial Research and the National Institute of Health.

CARL E. TREIBER died Nov. 3 at his home in Brookline, Mass. Mr. Treiber was born in Bavaria in 1860. For many years he had been an expert color chemist.

ISMAR GINSBERG died unexpectedly of a heart attack Nov. 24 in his apartment in New York at the age of 49 years. Mr. Ginsberg was a chemical engineering graduate from Columbia University and at the time of his death was a technical member of the editorial staff of the *Oil, Paint and Drug Reporter*.

HARRY B. EIGELBERNER, a food chemist and president of the Eigelberner Food Products Co., died Nov. 22 at his home in Chicago.

HENRY WARD BANKS, 3rd, chemical engineer and owner of the Banks Laboratory of New York, died Dec. 8 in a Stamford, Conn., hospital after a three-day illness. He was born in Englewood, N. J., 43 years ago, was a graduate of Williams College in the class of 1913, and was a fellow in chemistry at Columbia University.

ARTHUR EUGENE BRADY, vice-president and treasurer of Jenkins Bros., died Nov. 4, at his home in New York at the age of 58. Mr. Brady had been in poor health for several years, but had, during this time, maintained an active interest in the work of his office.

LESLIE WEBB, of the Pennsylvania Salt Manufacturing Co., died suddenly on Dec. 10 at his home in Philadelphia. Mr. Webb had recently been transferred to the main office from Pittsburgh. He had previously been manager of the Wedge Furnace organization. His many friends among the chemical and metallurgical industries will regret his loss.

## CALENDAR

AMERICAN CERAMIC SOCIETY, annual meeting, Cincinnati, Feb. 11-16, 1934.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, spring meeting, New York City, week of May 14, 1934.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY, spring meeting, New York, Feb. 19-22, 1934.

AMERICAN CHEMICAL SOCIETY, spring meeting, St. Petersburg, Fla., week of March 25, 1934.

ELECTROCHEMICAL SOCIETY, and AMERICAN CERAMIC SOCIETY, joint meeting, Asheville, N. C., April 26-28, 1934.

# CHEMICAL ECONOMICS

**Moderate decline in production of chemicals is reported for November although allowance for the difference in the number of working days would indicate but little variation in the rate of operation for the industry as a whole. The position of large consuming industries is favorable for expansion in production for the first quarter of next year.**

WIDE differences were reported in the rate of manufacturing operations in different branches of the chemical industry for November. In some cases, no change was made from the rate maintained in the preceding month, but rather sharp declines were reported elsewhere. By way of contrast, some producers—again including solvent production—reported larger outputs for the month despite the drop in the number of working days. The index number for the month was 130.5, which compares with 133.2 for October.

Statistics for October from different chemical-consuming industries make it possible to relate activities in those industries for the first ten months of the year with those for the like period in 1932. The table published herewith definitely reports the progress made this year.

Where data for November are available, the rate of increase appears to be well maintained. For instance, November operations of corn refiners have been at the heaviest rate in the history of the industry, according to the Corn Industries Research Foundation, the grind for the month approximating 9,000,000 bu., a step-up of more than 50 per cent above the normal for this period. This unusual activity reflects a general move on the part of users of starches, syrups, sugars, dextrines and other corn derivatives to anticipate the higher processing tax on products of corn which will shortly become effective.

Producers of blown and pressed glassware are reported to be holding production schedules at full capacity with no decline anticipated during December.

Automotive output is estimated at 60,000 units for November with present indications that December will add about 100,000 more and thus bring the total for the year above 2,000,000.

Sales of lacquers which are reported quarterly amounted to 16,410,350 gal. for the first three quarters of this year while sales for the entire year of 1932 amounted to but 16,252,821 gal. There was a decline of 9.4 per cent in the unit price of lacquers and if this holds true for the paint, varnish, and lacquer group sales of the latter, which are reported only in values, for the first ten months of this year would be more than 14.5 per cent larger in volume than those for the comparable period of last year and this gain will be increased for the twelve-month period.

Some tapering off in operation at textile centers is reported for the last two months of the year. The index of *Textile Organon* for rayon deliveries in November was 376 as compared with 399 for October. Other branches of the textile industry also are reported to have suffered some contraction. Deliveries of silk to mills, however, amounted to 34,882 bales compared with 28,521 bales in October and 43,955 bales in November, 1932.

Apparently the chemical and chemical-consuming industries have been holding up better than has industry as a whole. Volume of output in basic industries decreased in October, contrary to the usual seasonal tendency, the Federal Reserve Board reports in its monthly summary of business conditions. The board's seasonally adjusted index declined to 77 per cent of the 1923-25 average, from 84 per cent in September.

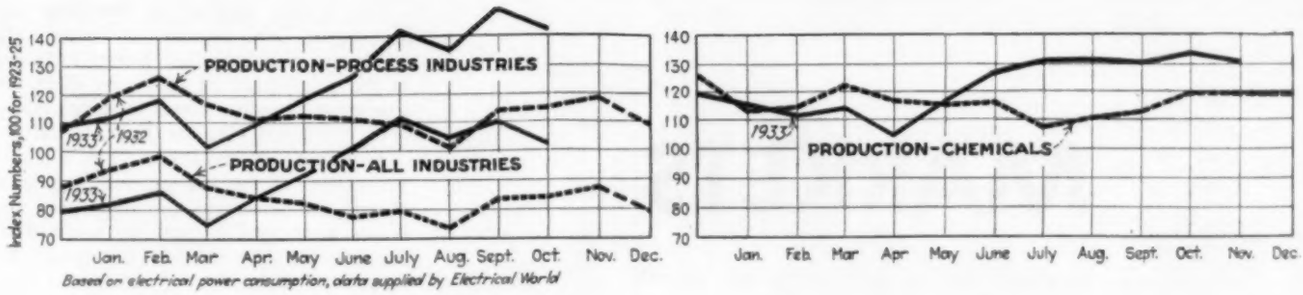
Factory employment and payrolls, after increasing continuously for six months up to the middle of September, showed little change from then to the middle of October, the board's index showed. However, there was an increase reported in the volume of construction contracts, which the board took to reflect the expansion of the Administration's public works program.

The total number of employes at factories, excluding canning establishments, showed little change from mid-September to mid-October. At canning establishments a seasonal decline was reported and the board's employment index, therefore, showed a decrease.

**Activities in Chemical and Chemical-Consuming Industries**

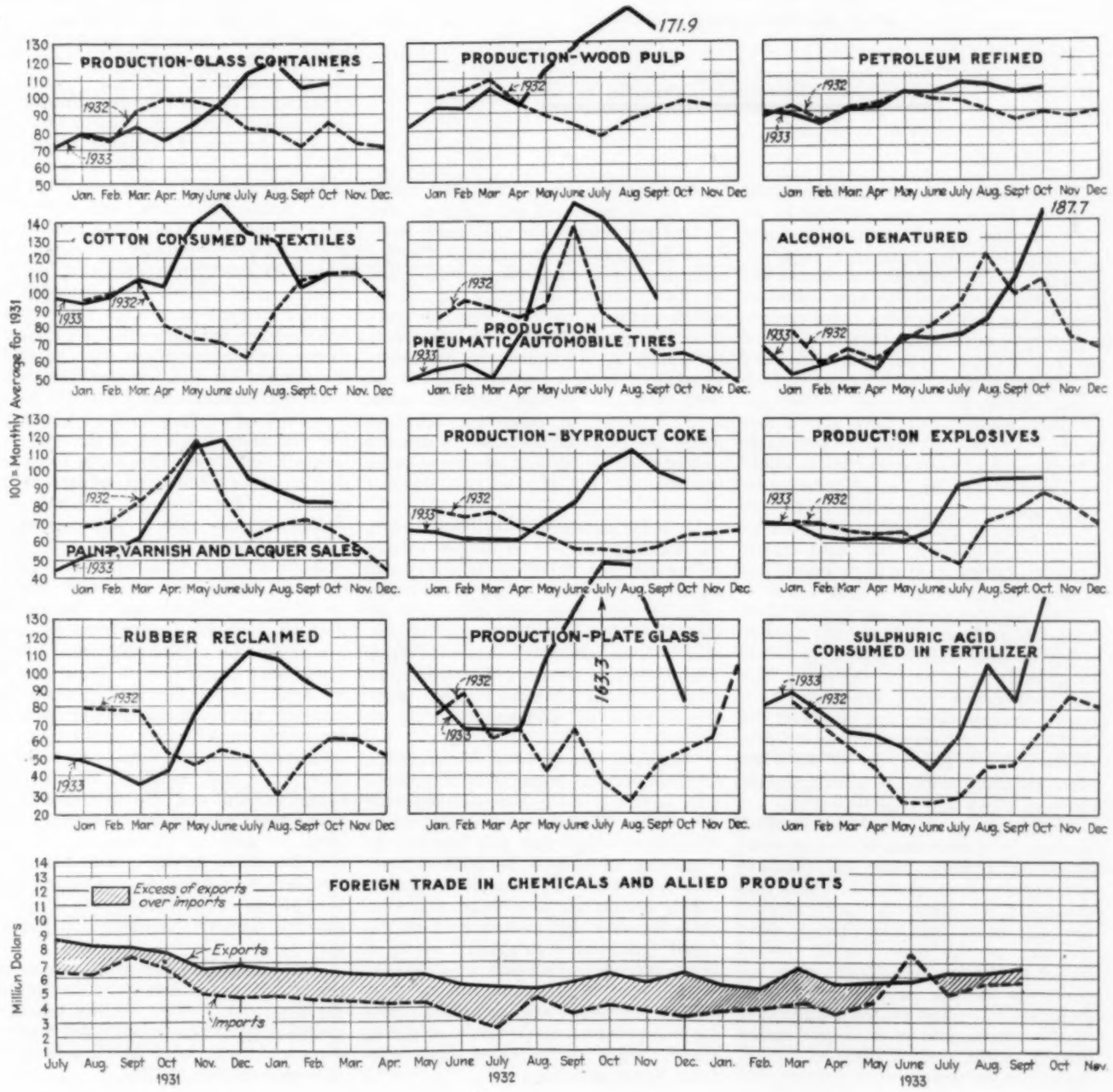
| | Oct. 1933 | Sept. 1933 | Oct. 1932 | Jan.-Oct. 1933 | Jan.-Oct. 1932 | Per Cent of Gain for Jan.-Oct. 1933 |
|---|---|---|---|---|---|---|
| PRODUCTION | | | | | | |
| Acetate of lime, 1000 lb. | 4,084 | 3,772 | 2,677 | 33,840 | 25,199 | 34.3 |
| Methanol, crude, 1000 gal. | 312 | 243 | 188 | 2,404 | 1,887 | 27.4 |
| Methanol, refined, 1000 gal. | 164 | 106 | 198 | 1,289 | 1,213 | 6.3 |
| Methanol, synthetic, 1000 gal. | 1,643 | 1,461 | 571 | 6,732 | 6,458 | 4.2 |
| Arsenic, crude, ton | 1,200 | 737 | 742 | 9,202 | 13,471 | 31.7x |
| Arsenic, refined, ton | 629 | 561 | 772 | 6,768 | 8,856 | 23.7x |
| Automobiles, No. | 138,475 | 196,082 | 48,702 | 1,811,242 | 1,203,768 | 50.5 |
| Byproduct coke, 1000 tons | 2,559 | 2,712 | 1,739 | 21,899 | 17,629 | 24.2 |
| Cotton finishing, 1000 yd. | 71,669 | 54,471 | 87,956 | 845,614 | 585,367 | 44.5 |
| Glass containers, 1000 gr. | 2,237 | 2,158 | 1,750 | 19,402 | 17,588 | 10.3 |
| Glass, plate, 1000 sq.ft. | 6,064 | 9,346 | 4,120 | 78,911 | 41,325 | 91.0 |
| Explosives, 1000 lb. | 25,084 | 25,107 | 23,749 | 202,792 | 174,821 | 16.0 |
| Petroleum refined, 1000 bbl. | 75,461 | 75,316 | 66,698 | 722,353 | 688,495 | 4.9 |
| Pyroxylin spread, 1000 lb. | 2,697 | 2,761 | 2,216 | 31,734 | 21,246 | 49.3 |
| Rosin, wood, bbl. | 44,821 | 43,213 | 33,132 | 346,530 | 281,416 | 23.2 |
| Turpentine, wood, bbl. | 6,929 | 6,642 | 5,202 | 54,644 | 45,430 | 20.3 |
| Sulphuric acid, in fertilizer trade, ton | 158,406 | 134,370 | 84,471 | 1,057,662 | 714,522 | 48.0 |
| Rubber reclaimed, ton | 8,898 | 9,809 | 6,275 | 76,101 | 59,511 | 27.9 |
| CONSUMPTION | | | | | | |
| Cotton, 1000 bales | 504 | 499 | 502 | 5,375 | 4,072 | 32.0 |
| Silk, bales | 28,521 | 31,185 | 53,703 | 407,646 | 469,315 | 13.1x |
| Wool, 1000 lb. | 51,037 | 50,467 | 42,423 | 442,593 | 310,027 | 42.7 |
| Paint, varnish and lacquer, sales, $1000. | 18,944 | 19,098 | 15,592 | 190,370 | 181,346 | 5.0 |
| Sulphuric acid, in fertilizer trade, ton | 160,688 | 94,881 | 74,813 | 902,328 | 564,394 | 59.9 |

x Per cent of decrease.




*Based on electrical power consumption, data supplied by Electrical World*

# TRENDS OF PRODUCTION AND CONSUMPTION



# MARKETS

**Contract buying increased last month with prices generally above those quoted for 1933 deliveries. Some producers refuse to quote ahead for the twelve-month period and restrict offers to the first six months. Contracts based on adjustments according to variations in wage scales and in the general price level also have been advocated.**

TRADING in chemicals throughout the last month was featured by an opening up of contract business covering deliveries over part or all of next year. The contract season was delayed this year, partly because delays in drawing up and approving codes created a feeling of uncertainty regarding future production costs and partly because fears of inflation deterred sellers from quoting freely on forward positions. In the case of some commodities there was a disposition to put into effect an adjustable contract whereby settlement prices would be variable according to adjustments in wage schedules or according to changes in the general price level as figured by recognized agencies. In most cases, however, future trading in chemicals has made progress along the usual lines.

New contract prices for carbon black have been changed from the former policy of quoting f.o.b. producing points to a basis of point of delivery. The delivered prices vary according to a zoning arrangement. For instance, the quotation for delivery to Atlantic Coast points is 5.35c. per lb. In all cases the new quotations represent advances over those in effect for 1933 deliveries.

Higher prices also apply on contract business in bichromates, silicate of soda, phosphates of soda, oxalic acid, glaubers salt, and for some grades of leaded zinc oxide. In all cases, the price tone is firm and belief that any changes after the turn of the year will be toward higher levels, has stimulated buying interest. It likewise has influenced some producers to restrict contract business to the first six months of next year rather than to extend current offers to the full twelve-month period.

Weather conditions have been favorable for an increased call for denatured alcohol and sales to the anti-freeze trade have been greatly stimulated. The industrial alcohol situation is complicated by the proposed marketing agreement which confines sales for beverage purposes to grain alcohol. Protests have been made by producers who use blackstrap molasses as a raw material. If the final decision permits alcohol made from molasses to enter the beverage trade, the resultant increase in demand undoubtedly would strengthen the price position for all grades of industrial alcohol.

Imported chemicals have been coming on domestic markets in larger volume in the last few months. This has followed logically as a result of improvement in consuming industries and by the favorable competitive position certain foreign chemicals have enjoyed. The exchange situation has served to increase prices for some foreign products but has not eliminated such competition.

Complaints have been filed against different foreign products in accordance with section 8 of the National Recovery Act dealing with the possible restriction of imports where they are found to be competing seriously with codified American industries. The materials against which complaints have been made include mercury and antimony. The National Quicksilver Producers' Association, representing producers in Oregon, Washington, California, Nevada, Arkansas, Arizona, Texas and Alaska, filed the complaint on importation of quicksilver, which is imported principally from Spain and Italy.

The Texas Mining & Smelting Co. of Laredo, Tex., reported to be the only company in the United States engaged in the production of antimony metal as a principal product direct from antimony ores, protested Chinese importations.

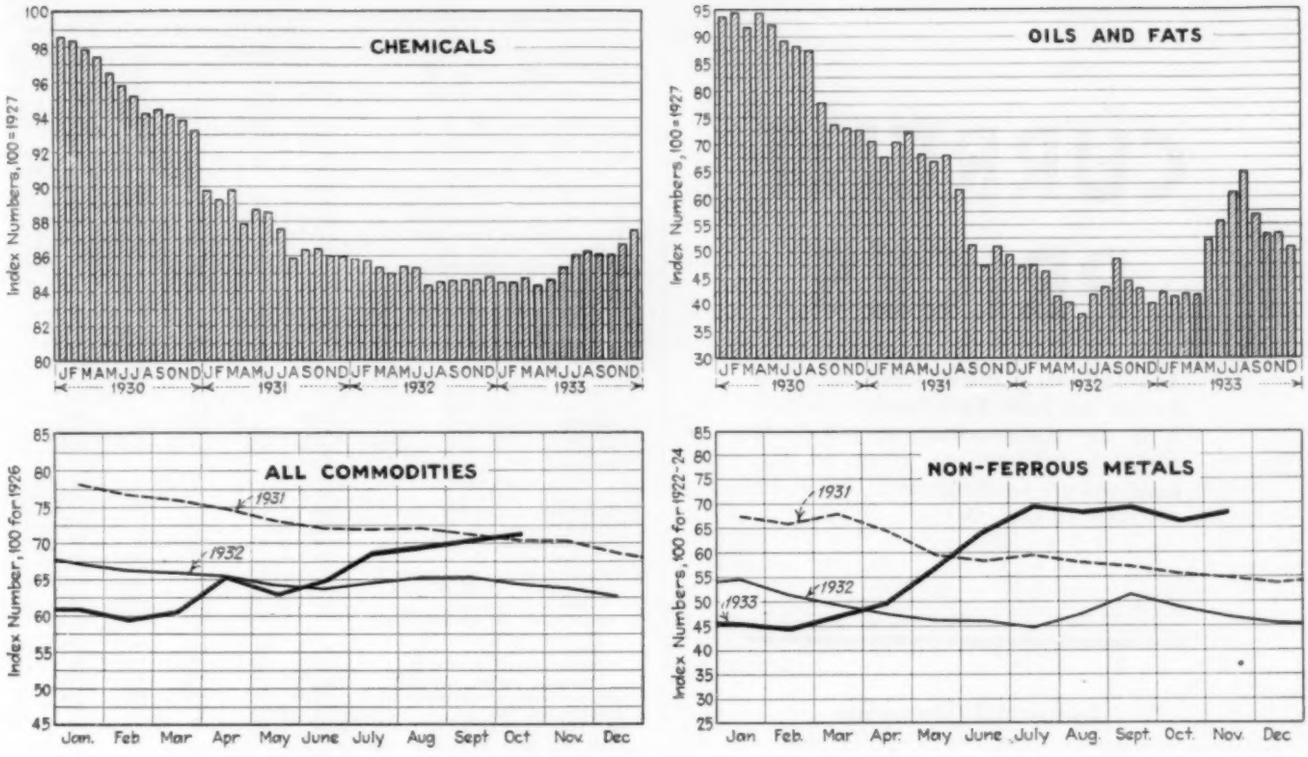
Following an investigation by Federal authorities of the alleged dumping here of sodium perborate, during which invoices were held up pending a decision, the Treasury Department has given instructions to U. S. Appraisers to proceed with appraisements in the customary manner, since the investigation did not unearth evidence to warrant a finding that this chemical was being dumped here.

Shipments of casein from the Argentine have fallen off recently and this material may be cited as an outstanding example where imports have been checked by the fall in the dollar. Current prices for casein for shipment from the Argentine are out of line with domestic quotations.

Statistics released by the Bureau of Agricultural Economics reveal that the total production of domestic casein by 195 factories during 1932 amounted to 24,428,000 pounds. Of this total 9,454,000 came from California, and 6,300,000 from Wisconsin. New York came next with 2,878,000 pounds. Illinois furnished 1,856,000 and Vermont 1,749,000 pounds, while 948,000 came from Idaho.

Developments in foreign markets as reported by the Department of Commerce included a report that to meet the competition of the fermentation acid citric acid manufacturers in Italy have, it is said, successfully evolved a process for obtaining citric acid direct from lemon juice. If the new method of production proves industrially advantageous and the old process is scrapped, the Italian domestic citrate of lime market will automatically disappear. In that case the Camera Agrumaria in its present form would have no further reason for existence. Furthermore, the formation of a Citrus Corporation as suggested by the Third National Citrus Congress recently held in Rome, would in itself render the existence of the present Camera Agrumaria unnecessary. Inasmuch as the entire question of the formation of commodity corporations, their scope and functions, is just now being worked out, the government is apparently awaiting the solution of this issue as well as the outcome of the new departure in citric acid manufacture before undertaking the reorganization of the citrus industry as a whole and the Camera Agrumaria in particular.

Also that Belgium was increasing production of sodium sulphate and in the first nine months of this year exported 26,669 metric tons to this country compared with 11,013 metric tons in the first nine months of 1932.




# PRICE TRENDS—CHEM. & MET.'S WEIGHTED INDEXES

FURTHER upward movement of prices for chemicals was recorded in the last month. With but few exceptions the new contract prices which have been established for shipment over all or over part of next year have been at levels higher than those in effect on 1933 contracts. Furthermore, in cases where no change in the open quotations has been made, business has been written on a basis more favorable to producers than was the case a year ago when competition assumed the form of cutting prices sharply below the quoted figures.

With more codes being approved and put into operation, a higher cost basis confronts all manufacturers, and this situation transcends everything else as a price factor. The point at interest just now is whether or not recent price advances have entirely discounted higher production costs and other contingencies which may arise. The general supposition is that commodity prices have not yet reached their highest levels and that some contract prices as well as quotations for spot trading will go through some adjustment in the coming year.

It is noted that there is a growing tendency to place quotations on a delivered basis and to divide the country into zones. Freight rates naturally are important in fixing the quotations for the different zones and the flat delivered price gives the same advantage as usual to plants situated near large consuming centers, but it also eliminates competition which ostensibly maintained quotations on a basis f.o.b. works but nullified them by equalizing freights to delivered points.

The processing tax of 20c. a bu. on corn which was scheduled to go into effect on Dec. 1 was postponed with no definite date for it to be put into operation. In the meantime the 5c. rate is effective. Nothing definite has yet developed in the way of placing processing taxes on materials competing with corn but such plans appear to be in prospect and molasses may be one of the materials, thus affected with a direct effect on the cost of producing industrial alcohol.

Depreciation of the dollar has had some effect of late in advancing the prices for some foreign chemicals and has resulted in a drop in trading for importation. In a few cases reported, the price of foreign offerings has brought a total cessation of such trading and has given a decided advantage to domestic offerings.

Values for vegetable oils and animal fats eased off somewhat during the period with a quiet consuming demand bringing about the weakness. The market appears to be marking time with no decided trend at present, although cottonseed oil appears to be working into a stronger position and an upswing in this oil would have a widespread effect on the entire oil market.

### Chem. & Met. Weighted Index of Chemical Prices

Base = 100 for 1927

| | |
|---|---|
| **This month** | **87.45** |
| Last month | 86.82 |
| December, 1932 | 84.81 |
| December, 1931 | 85.94 |

Price changes in the market for chemicals last month were almost entirely in favor of higher levels. Higher contract figures were named for bichromates and carbon gas black and numerous chemicals were marked up in spot trading.

### Chem. & Met. Weighted Index of Prices for Oils and Fats

Base = 100 for 1927

| | |
|---|---|
| **This month** | **51.89** |
| Last month | 53.11 |
| December, 1932 | 40.27 |
| December, 1931 | 49.40 |

The majority of vegetable oils eased off in price under a moderate buying movement. Oils of foreign origin were offered at concessions and the weaker position of coconut and China wood oils affected the market for domestic oils.

# CURRENT PRICES

The following prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to Dec. 15.

## Industrial Chemicals

| | Current Price | Last Month | Last Year |
|---|---|---|---|
| Acetone, drums, lb. | $0.10 -$0.10½ | $0.10 -$0.10½ | $0.10 -$0.11 |
| Acid, acetic, 28%, bbl., cwt. | 2.90 - 3.15 | 2.90 - 3.15 | 2.65 - 2.90 |
| Glacial 99%, drums | 10.02 -10.27 | 10.02 -10.27 | 8.89 - |
| U. S. P. reagent, c'bys | 10.52 -10.77 | 10.52 -10.77 | 9.64 - 9.89 |
| Boric, bbl., lb. | .04½- .05 | .04½- .05 | .04½- .05 |
| Citric, kegs, lb. | .29 - .31 | .29 - .31 | .29 - .31 |
| Formic, bbl., lb. | .11 - .11½ | .11 - .11½ | .10 - .11 |
| Gallic, tech., bbl., lb. | .60 - .65 | .60 - .65 | .50 - .55 |
| Hydrofluoric 30% carb., lb. | .07 - .07½ | .07 - .07½ | .06 - .07 |
| Lactic, 44%, tech., light, bbl., lb. | .11½- .12 | .11½- .12 | .11½- .12 |
| 22%, tech., light, bbl., lb. | .05½- .06 | .05½- .06 | .05½- .06 |
| Muriatic, 18° tanks, cwt. | 1.00 - 1.10 | 1.00 - 1.10 | 1.00 - 1.10 |
| Nitric, 36°, carboys, lb. | .05 - .05½ | .05 - .05½ | .05 - .05½ |
| Oleum, tanks, wks., ton | 18.50 -20.00 | 18.50 - | 18.50 -20.00 |
| Oxalic, crystals, bbl., lb. | .11½- .12½ | .11 - .11½ | .11 - .12 |
| Phosphoric, tech., c'bys., lb. | .09 - .10 | .09 - .10 | .08½- .09 |
| Sulphuric, 60°, tanks, ton | 11.00 -11.50 | 11.00 -11.50 | 11.00 -11.50 |
| Sulphuric, 66°, tanks, ton | 15.50 - | 15.50 - | 15.50 - |
| Tannic, tech., bbl., lb. | .23 - .35 | .23 - .35 | .23 - .35 |
| Tartaric, powd., bbl., lb. | .25½- .26 | .25 - .25½ | .20 - .21 |
| Tungstic, bbl., lb. | 1.40 - 1.50 | 1.40 - 1.50 | 1.40 - 1.50 |
| Alcohol, ethyl, 190 p'f., bbl., gal. | 2.415- | 2.415- | 2.53½- |
| Alcohol, Butyl, tanks, lb. | .095- | .095- | .113- |
| Alcohol, Amyl | - | - | - |
| From Pentane, tanks, lb. | .15 - | .15 - | .182- |
| Denatured, 190 proof | | | |
| No. 1 special dr., gal. | .346- | .346- | .34½- |
| No. 5, 188 proof, dr., gal. | .34 - | .34 - | .38½- |
| Alum, ammonia, lump, bbl., lb. | .03 - .04 | .03 - .04 | .03 - .04 |
| Chrome, bbl., lb. | .04½- .05 | .04½- .05 | .04½- .05 |
| Potash, lump, bbl., lb. | .03 - .04 | .03 - .04 | .03 - .04 |
| Aluminum sulphate, com., bags, cwt. | 1.35 - 1.50 | 1.25 - 1.40 | 1.25 - 1.40 |
| Iron free, bg., cwt. | 1.90 - 2.00 | 1.90 - 2.00 | 1.90 - 2.00 |
| Aqua ammonia, 26°, drums lb. | .02½- .03 | .02½- .03 | .02½- .03 |
| tanks, lb. | .02½- .02¾ | .02½- .02¾ | .02½- .02¾ |
| Ammonia, anhydrous, cyl., lb. | .14 - .14½ | .14 - .14½ | .15½- .15¾ |
| tanks, lb. | .05 - | .05 - | .05 - |
| Ammonium carbonate, powd. tech., casks, lb. | .08 - .12 | .08 - .12 | .10 - .11 |
| Sulphate, wks., cwt. | 1.25 - | 1.20 - | 1.025- |
| Amylacetate tech., tanks, lb., gal | .14½- | .14½- | .16 - |
| Antimony Oxide, bbl., lb. | .08½- .10 | .08½- .10 | .07 - .08 |
| Arsenic, white, powd., bbl., lb. | .04 - .04½ | .04 - .04½ | .04 - .04½ |
| Red, powd., kegs, lb. | .14 - .14½ | .14 - .14½ | .09 - .10 |
| Barium carbonate, bbl., ton | 56.50 -58.00 | 56.50 -58.00 | 56.50 -58.00 |
| Chloride, bbl., ton | 74.00 -75.00 | 74.00 -75.00 | 63.00 -65.00 |
| Nitrate, cask, lb. | .08½- .09 | .08½- .09 | .07 - .07½ |
| Blanc fixe, dry, bbl., lb. | .03½- .04 | .03½- .04 | .03½- .04 |
| Bleaching powder, f.o.b., wks., drums, cwt. | 1.85 - 2.00 | 1.85 - 2.00 | 1.75 - 2.00 |
| Borax, grain, bags, ton | 40.00 -45.00 | 40.00 -45.00 | 40.00 -45.00 |
| Bromine, cs., lb. | .36 - .38 | .36 - .38 | .36 - .38 |
| Calcium acetate, bags | 3.00 - | 3.00 - | 2.50 - |
| Arsenate, dr., lb. | .07 - .08 | .07 - .08 | .05½- .06½ |
| Carbide drums, lb. | .05 - .06 | .05 - .06 | .05 - .06 |
| Chloride, fused, dr., wks., ton. | 17.50 - | 17.50 - | 18.00 - |
| flake, dr., wks., ton. | 19.50 - | 19.50 - | 21.00 - |
| Phosphate, bbl., lb. | .07½- .08 | .07½- .08 | .07½- .08 |
| Carbon bisulphide, drums, lb. | .05½- .06 | .05½- .06 | .05 - .06 |
| Tetrachloride drums, lb. | .05½- .06 | .05½- .06 | .06½- .07 |
| Chlorine, liquid, tanks, wks., lb. | .0185- | .0185- | .01½- |
| Cylinders | .05½- .06 | .05½- .06 | .05½- .06 |
| Cobalt oxide, cans, lb. | 1.35 - 1.40 | 1.15 - 1.25 | 1.25 - 1.35 |
| Copperas, bgs., f.o.b. wks., ton. | 14.00 -15.00 | 14.00 -15.00 | 13.00 -14.00 |
| Copper carbonate, bbl., lb. | .08½- .16 | .08½- .16 | .07 - .16 |
| Cyanide, tech., bbl., lb. | .39 - .44 | .39 - .44 | .39 - .44 |
| Sulphate, bbl., cwt. | 3.75 - 4.00 | 3.75 - 4.00 | 3.00 - 3.25 |
| Cream of tartar, bbl., lb. | .18 - .18½ | .18 - .18½ | .16 - .16½ |
| Diethylene glycol, dr., lb. | .14 - .16 | .14 - .16 | .14 - .16 |
| Epsom salt, dom., tech., bbl., cwt. | 2.10 - 2.15 | 2.10 - 2.15 | 1.70 - 2.00 |
| Imp., tech., bags, cwt. | 2.00 - 2.10 | 2.00 - 2.10 | 1.15 - 1.25 |
| Ethyl acetate, drums, lb. | .08½- | .08½- | .09½- |
| Formaldehyde, 40%, bbl., lb. | .06 - .07 | .06 - .07 | .06 - .07 |
| Furfural, dr., contract, lb. | .10 - .17½ | .10 - .17½ | .10 - .17½ |
| Fusel oil, crude, drums, gal. | .75 - | .75 - | 1.10 - 1.20 |
| Refined, dr., gal. | 1.25 - 1.30 | 1.25 - 1.30 | 1.80 - 1.90 |
| Glaubers salt, bags, cwt. | 1.00 - 1.10 | 1.00 - 1.10 | 1.00 - 1.10 |
| Glycerine, c.p., drums, extra, lb. | .11 - .11½ | .10½- .10½ | .10½- .10½ |
| Lead: | | | |
| White, basic carbonate, dry casks, lb. | .06½- | .06½- | .06½- |
| White, basic sulphate, sck., lb. | .06 - | .06 - | .06 - |
| Red, dry, sck., lb. | .07½- | .07½- | .06½- |
| Lead acetate, white crys., bbl., lb. | .10½- .11 | .10½- .11 | .10 - .11 |
| Lead arsenate, powd., bbl., lb. | .10 - .13 | .10 - .13 | .09½- .14 |
| Lime, chem., bulk, ton | 8.50 - | 8.50 - | 8.50 - |
| Litharge, pwd., csk, lb. | .06½- | .06½- | .05½- |
| Lithophone, bags, lb. | .04½- .05 | .04½- .05 | .04½- .05 |
| Magnesium carb., tech., bags, lb. | .06 - .06½ | .06 - .06½ | .05½- .06 |
| Methanol, 95%, tanks, gal. | .33 - | .33 - | .33 - |
| 97%, tanks, gal. | .34 - | .34 - | .34 - |
| Synthetic, tanks, gal. | .35½- | .35½- | .35½- |
| Nickel salt, double, bbl., lb. | .12 - .12½ | .12 - .12½ | .11 - .11½ |
| Orange mineral, csk., lb. | .10½- | .10½- | .09½- |
| Phosphorus, red, cases, lb. | .45 - .46 | .45 - .46 | .42 - .44 |
| Yellow, cases, lb. | .28 - .32 | .28 - .32 | .28 - .32 |
| Potassium bichromate, casks, lb. | .07½- .08½ | .07½- .08 | .07½- .08 |
| Carbonate, 80-85%, calc. csk., lb | .07 - .07½ | .07 - .07½ | .05 - .06 |
| Chlorate, powd., lb. | .09 - .09½ | .08½- .08½ | .08 - .08½ |
| Hydroxide (c'stic potash) dr., lb. | .07½- .07½ | .07½- .07½ | .06½- .06½ |
| Muriate, 80% bgs., ton | 37.15 - | 37.15 - | 37.15 - |
| Nitrate, bbl., lb. | .05½- .06 | .05½- .06 | .05½- .06 |
| Permanganate, drums, lb. | .17½- .18 | .17½- .18 | .16 - .16½ |
| Prussiate, yellow, casks, lb. | .18 - .19 | .16½- .17 | .18½- .19 |
| Sal ammoniac, white, casks, lb. | .04½- .05 | .04½- .05 | .04½- .05 |
| Salsoda, bbl., cwt. | 1.00 - 1.05 | 1.00 - 1.05 | .90 - .95 |
| Salt cake, bulk, ton | 13.00 -15.00 | 13.00 -15.00 | 13.00 -15.00 |
| Soda ash, light, 58%, bags, contract, cwt. | 1.23 - | 1.23 - | 1.15 - |
| Dense, bags, cwt. | 1.25 - | 1.25 - | 1.17½- |
| Soda, caustic, 76%, solid, drums, contract, cwt. | 2.60 - 3.00 | 2.60 - 3.00 | 2.50 - 2.75 |
| Acetate, works, bbl., lb. | .04½- .05 | .04½- .05 | .05 - .05½ |
| Bicarbonate, bbl., cwt. | 1.85 - 2.00 | 1.85 - 2.00 | 1.85 - 2.00 |
| Bichromate, casks, lb. | .05½- .06½ | .05 - .05½ | .05 - .06 |
| Bisulphate, bulk, ton | 14.00 -16.00 | 14.00 -16.00 | 14.00 -16.00 |
| Bisulphite, bbl., lb. | .03 - .04 | .03 - .04 | .03½- .04 |
| Chlorate, kegs, lb. | .06½- .06½ | .05½- .07½ | .05½- .07½ |
| Chloride, tech., ton | 12.00 -14.75 | 12.00 -14.75 | 12.00 -14.00 |
| Cyanide, cases, dom., lb. | .15½- .16 | .15½- .16 | .15½- .16 |
| Fluoride, bbl., lb. | .07½- .08 | .07½- .08 | .07½- .08 |
| Hyposulphite, bbl., lb. | 2.40 - 2.50 | 2.40 - 2.50 | 2.40 - 2.50 |
| Metasilicate, bbl., cwt. | 3.25 - 3.40 | 3.25 - 3.40 | 3.60 - 3.75 |
| Nitrate, bags, cwt. | 1.295- | 1.295- | 1.295- |
| Nitrite, casks, lb | .07½- .08 | .07½- .08 | .07½- .08 |
| Phosphate, dibasic, bbl., lb. | .021- .023 | .021- .023 | .018- .02 |
| Prussiate, yel. drums, lb. | .11½- .12 | .11½- .12 | .11½- .12 |
| Silicate (40° dr.) wks. cwt. | .80 - .85 | .70 - .75 | .70 - .75 |
| Sulphide, fused, 60-62%, dr., lb. | .02½- .03½ | .02½- .03 | .02½- .03 |
| Sulphite, cyrs., bbl., lb. | .02½- .02½ | .02½ .02½ | .03 - .03½ |
| Sulphur, crude at mine, bulk, ton | 18.00 - | 18.00 - | 18.00 - |
| Chloride, dr., lb. | .03½- .04 | .03½- .04 | .03½- .04 |
| Dioxide, cyl., lb. | .07 - .07½ | .06½- .07 | .06½- .07 |
| Flour, bag, cwt. | 1.55 - 3.00 | 1.55 - 3.00 | 1.55 - 3.00 |
| Tin Oxide, bbl. lb. | .57 - | .52 - | .27½- |
| Crystals, bbl., lb. | .39 - | .40 - | .24 - |
| Zinc chloride, gran., bbl., lb. | .05½- .06 | .05½- .06 | .06½- .06½ |
| Carbonate, bbl., lb. | .09½- .11 | .09½- .11 | .10½- .11 |
| Cyanide, dr., lb. | .38 - .42 | .38 - .42 | .41 - .42 |
| Dust, bbl., lb. | .07 - .07½ | .07 - .07½ | .04½- .05 |
| Zinc oxide, lead free, bag, lb. | .05½- | .05½- | .05½- |
| 5% lead sulphate, bags, lb. | .05½- | .05½- | .05½- |
| Sulphate, bbl., cwt. | 3.00 - 3.25 | 3.00 - 3.25 | 3.00 - 3.25 |

## Oils and Fats

| | Current Price | Last Month | Last Year |
|---|---|---|---|
| Castor oil, No. 3, bbl., lb. | $0.09½-$0.10 | $0.05½-$0.10 | $0.08½-$0.09 |
| Chinawood oil, bbl., lb. | .07½- | .08 - | .05½- |
| Coconut oil, Ceylon, tanks, N. Y. lb. | .02½- | .03 - | .03½- |
| Corn oil crude, tanks, (f.o.b. mill), lb | .03¾- | .04 - | .03 - |
| Cottonseed oil, crude (f.o.b. mill), tanks, lb. | .03½- | .03½- | .02½- |
| Linseed oil, raw car lots, bbl., lb. | .095- | .097- | .062- |
| Palm, Lagos, casks, lb. | .04 - | .04 - | .03½- |
| Palm Kernel, bbl., lb. | .04½- | .04 - | .04½- |
| Peanut oil, crude, tanks (mill), lb. | .03½- | .03½- | .03½- |
| Rapeseed oil, refined, bbl., gal. | .42 - .43 | .42 - .43 | .31 - .32 |
| Soya bean, tank, lb. | .06½- | .06½- | - |
| Sulphur (olive foots), bbl., lb. | .06½- | .06½- | .04½- |
| Cod, Newfoundland, bbl., gal. | .34 - .35 | .33 - .35 | .23 - .26 |
| Menhaden, light pressed, bbl., lb. | .053- | .053- | .03½- |
| Crude, tanks (f.o.b. factory), gal. | .17 - | .13 - | .09½- |
| Grease, yellow, loose, lb. | .02½- | .02½- | .02½- |
| Oleo stearine, lb. | .05½- | .05½- | .04½- |
| Red oil, distilled, d.p. bbl., lb. | .06½- | .06½- | .06½- |
| Tallow, extra, loose, lb. | .03½- | .03 - | .02½- |

## Coal-Tar Products

| | Current Price | Last Month | Last Year |
|---|---|---|---|
| Alpha-naphthol, crude, bbl., lb. | $0.60 -$0.65 | $0.60 -$0.65 | $0.60 -$0.62 |
| Refined, bbl., lb. | .80 - .85 | .80 - .85 | .80 - .85 |
| Alpha-naphthylamine, bbl., lb. | .32 - .34 | .32 - .34 | .32 - .34 |
| Aniline oil, drums, extra, lb. | .14½- .15 | .14½- .15 | .14½- .15 |
| Aniline salts, bbl., lb. | .24 - .25 | .24 - .25 | .24 - .52 |
| Benzaldehyde, U.S.P., dr., lb. | 1.10 - 1.25 | 1.10 - 1.25 | 1.10 - 1.25 |
| Benzidine base, bbl., lb. | .65 - .67 | .65 - .67 | .65 - .67 |
| Benzoic acid, U.S.P., kgs, lb. | .48 - .52 | .48 - .52 | .48 - .52 |
| Benzyl chloride, tech., dr., lb. | .30 - .35 | .30 - .35 | .30 - .35 |
| Benzol, 90%, tanks, works, gal. | .22 - .23 | .22 - .23 | .20 - .21 |
| Beta-naphthol, tech., drums, lb. | .22 - .24 | .22 - .24 | .22 - .24 |
| Cresol, U. S. P., dr., lb. | .11 - .11½ | .10½- .11 | .10½- .11 |
| Cresylic acid, 97%, dr., wks., gal. | .50 - .51 | .45 - .46 | .49 - .52 |
| Diethylaniline, dr., lb. | .55 - .58 | .55 - .58 | .55 - .58 |
| Dinitrophenol, bbl., lb. | .29 - .30 | .29 - .30 | .29 - .30 |
| Dinitrotoluen, bbl. lb. | .16 - .17 | .16 - .17 | .16 - .17 |
| Dip oil 25% dr., gal. | .23 - .25 | .23 - .25 | .23 - .25 |
| Diphenylamine, bbl., lb. | .38 - .40 | .38 - .40 | .38 - .40 |
| H-acid, bbl., lb. | .65 - .70 | .65 - .70 | .65 - .70 |
| Naphthalene, flake, bbl., lb. | .06 - .07 | .06 - .07 | .04½- .05 |
| Nitrobenzene, dr., lb. | .08½- .09 | .08½- .09 | .08½- .10 |
| Para-nitraniline, bbl., lb. | .51 - .55 | .51 - .55 | .51 - .55 |
| Phenol, U.S.P., drums, lb. | .14½- .15 | .14½- .15 | .14½- .15 |
| Picric acid, bbl., lb. | .30 - .40 | .30 - .40 | .30 - .40 |
| Pyridine, dr., gal. | 1.10 - 1.15 | .90 - .95 | 1.50 - 1.80 |
| R-salt, bbl., lb. | .40 - .44 | .40 - .44 | .40 - .44 |
| Resorcinal, tech., kegs, lb. | .65 - .70 | .65 - .70 | .65 - .70 |
| Salicylic acid, tech., bbl., lb. | .40 - .42 | .40 - .42 | .33 - .35 |
| Solvent naphtha, w.w., tanks, gal. | .26 - | .26 - | .26 - |
| Tolidine, bbl., lb. | .88 - .90 | .88 - .90 | .86 - .88 |
| Toluene, tanks, works, gal. | .30 - | .30 - | .30 - |
| Xylene, com., tanks, gal. | .26 - | .26 - | .26 - |

## Miscellaneous

| | Current Price | Last Month | Last Year |
|---|---|---|---|
| Barytes, grd., white, bbl., ton | $22.00-$25.00 | $22.00-$25.00 | $22.00-$25.00 |
| Casein, tech., bbl., lb. | .12½- .13 | .12½- .13 | .06- .10½ |
| China clay, dom., f.o.b. mine, ton | 8.00 -20.00 | 8.00 -20.00 | 8.00 -20.00 |
| Dry colors: | | | |
| Carbon gas, black (wks.), lb. | .04 - .20 | .02½- .20 | .02½- .20 |
| Prussian blue, bbl., lb. | .35 - .36 | .35 - .36 | .35 - .36 |
| Ultramine blue, bbl., lb. | .06 - .32 | .06 - .32 | .06 - .32 |
| Chrome green, bbl., lb. | .26 - .27 | .26 - .27 | .27 - .30 |
| Carmine red, tins, lb. | 3.65 - 3.75 | 3.65 - 3.75 | 3.90 - 4.50 |
| Para toner, lb. | .80 - .85 | .80 - .85 | .75 - .80 |
| Vermilion, English, bbl., lb. | 1.40 - 1.45 | 1.35 - 1.40 | 1.25 - 1.50 |
| Chrome yellow, C. P., bbl., lb. | .15 - .15½ | .15 - .15½ | .16 - .16½ |
| Feldspar, No. 1 (f.o.b. N.C.), ton | 6.50 - 7.50 | 6.50 - 7.50 | 6.50 - 7.50 |
| Graphite, Ceylon, lump, bbl., lb. | .07 - .08½ | .07 - .08½ | .07 - .08½ |
| Gum copal Congo, bags, lb. | .08 - .09 | .08 - .09 | .06 - .08 |
| Manila, bags, lb. | .09 - .10 | .09 - .10 | .16 - .17 |
| Damar, Batavia, cases, lb. | .15 - .15½ | .15 - .15½ | .16 - .16½ |
| Kauri No. 1 cases, lb. | .20 - .25 | .20 - .25 | .45 - .48 |
| Kieselguhr (f.o.b. N.Y.), ton | 50.00 -55.00 | 50.00 -55.00 | 50.00 -55.00 |
| Magnesite, calc, ton | 50.00 - | 50.00 - | 40.00 - |
| Pumice stone, lump, bbl., lb. | .05 - .07 | .05 - .08 | .05 - .07 |
| Imported, casks, lb. | .03 - .40 | .03 - .40 | .03 - .35 |
| Rosin, H., bbl. | 4.90 - | 5.15 - | 3.80 - |
| Turpentine, gal. | .46½- | .48½- | .42 - |
| Shellac, orange, fine, bags, lb. | .22 - .23 | .24 - .25 | .20 - .25 |
| Bleached, bonedry, bags, lb. | .24 - .25 | .24 - .25 | .18 - .19 |
| T. N. bags, lb. | .15 - .15½ | .13 - .14 | .09½- .10 |
| Soapstone (f.o.b. Vt.), bags, ton | 10.00 -12.00 | 10.00 -12.00 | 10.00 -12.00 |
| Talc, 200 mesh (f.o.b. Vt.), ton | 8.00 - 8.50 | 8.00 - 8.50 | 8.00 - 8.50 |
| 300 mesh (f.o.b Ga.), ton | 7.50 -10.00 | 7.50 -10.00 | 7.50 -11.00 |
| 225 mesh (f.o.b. N. Y.), ton | 13.75 - | 13.75 - | 13.75 - |
| Wax, Bayberry, bbl., lb. | .15 - .16 | .15 - .16 | .16 - .20 |
| Beeswax, ref., light, lb. | .22 - .27 | .22 - .27 | .20 - .30 |
| Candelilla, bags, lb. | .11 - .12 | .09 - .09½ | .12 - |
| Carnuba, No. 1, bags, lb. | .31 - .32 | .27 - .29 | .22 - .24 |
| Paraffine, crude | | | |
| 105-110 m.p., lb. | .04 - | .04 - | .03½- .03½ |

## Price Changes During Month

| Advanced | Declined |
|---|---|
| Oxalic acid | Vegetable oils |
| Ammonium sulphate | Copper |
| Cobalt oxide | Tin |
| Tartaric acid | Silver |
| Sodium bichromate | |
| Potassium bichromate | |
| Cresylic acid | |
| Pyridine | |
| Carbon black | |

## Ferro-Alloys

| | Current Price | Last Month | Last Year |
|---|---|---|---|
| Ferrotitanium, 15-18%, ton. | $200.00- | $200.00- | $200.00- |
| Ferromanganese, 78-82%, ton. | 82.00- | 82.00- | 68.00- |
| Ferrochrome, 65-70% | .09½- | .09½- | .10- |
| Spiegeleisen, 19-21% ton. | 27.00- | 27.00- | 25.00- |
| Ferrosilicon, 14-17%, ton. | 31.00- | 31.00- | 31.00- |
| Ferrotungsten, 70-80%, lb. | 1.15- 1.25 | 1.05- | 1.00- 1.10 |
| Ferrovanadium, 30-40%, lb. | 2.60- 2.80 | 2.60- 2.80 | 3.05- 3.40 |

## Non-Ferrous Metals

| | Current Price | Last Month | Last Year |
|---|---|---|---|
| Copper, electrolytic, lb. | $0.08 - | $0.08½- | $0.05½- |
| Aluminum, 96-99%, lb. | .229- | .229- | .229- |
| Antimony, Chin. and Jap., lb. | .07½- | .072- | .05½- |
| Nickel, 99%, lb. | .35 - | .35 - | .35 - |
| Monel metal blocks, lb. | .28 - | .28 - | .28 - |
| Tin, 5-ton lots, Straits, lb. | .52½- | .55 - | .22½- |
| Lead, New York, spot, lb. | .0415- | .043 - | .03 - |
| Zinc, New York, spot, lb. | .0487- | .0485- | .035 - |
| Silver, commercial, oz. | .43½- | .45 - | .24½- |
| Cadmium, lb. | .55 - | .55 - | .55 - |
| Bismuth, ton lots, lb. | 1.20 - | 1.20 - | .85 - |
| Cobalt, lb. | 2.50 - | 2.50 - | 2.50 - |
| Magnesium, ingots, 99%, lb. | .32 - | .32 - | .30 - |
| Platinum, ref., oz. | 37.00 - | 36.00 - | 30.00 - |
| Palladium, ref., oz. | 21.00 - | 21.00 - | 17.00 - 18.00 |
| Mercury, flask, 75 lb. | 66.00 - | 66.00 - | 48.00 - |
| Tungsten powder, lb. | 1.25 - | 1.25 - | 1.45 - |

## Ores and Semi-finished Products

| | Current Price | Last Month | Last Year |
|---|---|---|---|
| Bauxite, crushed, wks., ton. | $6.50 -$8.25 | $6.50 -$8.25 | $6.50 -$8.25 |
| Chrome ore, c.i.f. ports, ton. | 16.00 -20.00 | 16.00 -20.00 | 17.00 -20.00 |
| Coke, fdry., f.o.b. ovens, ton. | 4.25 - | 4.25 - | 3.25 - 3.75 |
| Fluorspar, gravel, f.o.b. Ill., ton. | 17.25 -20.00 | 17.25 -20.00 | 17.25 -20.00 |
| Manganese ore, 50% Mn., c.i.f. Atlantic Ports, unit. | .20 - | .19 - | .23 - |
| Molybdenite, 85% $MoS_2$ per lb. $MoS_2$, N. Y., lb. | .45 - | .45 - | .45 - |
| Monazite, 6% of $ThO_2$, ton. | 60.00 - | 60.00 - | 60.00 - |
| Pyrites, Span. fines, c.i.f., unit. | .13 - | .13 - | .13 - |
| Rutile, 94-96% $TiO_2$, lb. | .10 - .11 | .10 - .11 | .10 - .11 |
| Tungsten, scheelite, 60% $WO_3$ and over, unit. | 14.00 - | 12.00 - | 7.50 - 9.75 |

# INDUSTRIAL NOTES

COMBUSTION ENGINEERING CO., INC., New York, announces the appointment of James Cleary as manager of the Philadelphia sales district and of Fred L. Farrell as manager of New England sales territory with headquarters in Boston.

NORTHERN PUMP CO., Minneapolis, has elected Hugh L. Rusch, vice-president and appointed him as eastern sales manager with headquarters in the Chrysler Bldg., New York.

PURE CARBONIC, INC., New York, has placed A. M. Jackson in charge of sales in the Colorado territory.

MCKESSON & ROBBINS have moved their executive and sales offices to 155 East 44th St., New York. The crude drug, heavy chemical, and export departments will remain at 79 Cliff St.

FOOTE BROS. GEAR & MACHINE CO., Chicago, has appointed E. Akridge and George E. Popelar as sales engineers for the Chicago territory.

STRUTHER-WELLS TITUSVILLE CORP., Warren, Pa., has appointed the Mine and Smelter Supply Co., Denver, Colo., as its representative in the Rocky Mountain district. Also the Yuba Mfg. Co., San Francisco, to handle sales in California, Washington, and Oregon and O. E. Berg, Houston, Tex., as representative for Oklahoma, Louisiana, and eastern Texas.

THE AMERICAN CYANAMID CO., New York, has acquired the General Explosives Corp., with general offices and works at Latrobe, Pa.

JOSEPH TURNER & CO., has moved from 19 Cedar St., to 500 Fifth Ave., New York. Among the firms represented by the company are the Niagara Alkali Co., Oldbury Electro Chemical Co., Buffalo Electro Chemical Co. and the Colonial Salt Co.

THE PODBIELNIAK INDUSTRIAL RESEARCH AND ANALYTICAL LABORATORIES has been established at 222 East Superior St., Chicago.

THE RIVERSIDE BOILER WORKS, Cambridge, Mass., announces that William R. Grunow recently has joined the company in the capacity of sales engineer.

THE VALLE CO., Cleveland, announces that Phillip L. Maury, former president of the Arco Co., has joined the company and will serve as executive vice-president and treasurer. The Valle Co. manufactures paint, varnish, and lacquers.

# NEW CONSTRUCTION

Where Plants Are Being Built in Process Industries

| | This Month | | Cumulative to Date | |
|---|---|---|---|---|
| | Proposed Work and Bids | Contracts Awarded | Proposed Work and Bids | Contract Awarded |
| New England | $30,000 | ..... | $534,000 | $215,000 |
| Middle Atlantic | 291,000 | $123,000 | 8,075,000 | 4,879,000 |
| Southern | 1,569,000 | 5,100,000 | 13,853,000 | 12,348,000 |
| Middle West | 2,200,000 | ..... | 3,825,000 | 1,089,000 |
| West of Mississippi | 240,000 | 28,000 | 14,699,000 | 14,183,000 |
| Far West | 100,000 | 197,000 | 4,880,000 | 2,844,000 |
| Canada | 1,098,000 | ..... | 7,564,000 | 3,041,000 |
| Total | $5,528,000 | $5,448,000 | $53,430,000 | $38,599,000 |

## PROPOSED WORK BIDS ASKED

**Benzol Plant** — Dublin Gas Co., Irish Free State, Dublin, Ireland, is interested in prices for constructing and equipping a benzol plant.

**Chemical Plant** — R. W. Hilton, c/o Penn Charcoal & Chemical Co., Smethport, Pa., has acquired the idle plant of the Morris Chemical Co., Morris, Pa., and plans to rehabilitate same and install new machinery and equipment. Expect to start work early next year. Estimated cost to exceed $28,000.

**Chemical Plant**—Rostrom Chemical Co., c/o Thomas Rostrom, Oshawa, Ont., contemplates the construction of a chemical plant. Estimated cost $40,000.

**Distillery**—Hammond Distilleries, c/o Maxwell Nowack, Calumet Ave. and East 150th St., Hammond, Ind., contemplate the construction of a liquor distillery. Estimated cost $100,000.

**Fertilizer Plant** — International Agricultural Chemical Corp., East Macon, Ga., and Mortgage Guaranty Bldg., Atlanta, Ga., contemplates the construction of a fertilizer plant at East Macon. New equipment will be needed. Estimated cost $35,000.

**Fertilizer Plant**—Tennessee Valley Authority, Knoxville, Tenn., having plans prepared by Stone & Webster, Engrs., 90 Broad St., New York, N. Y., for the construction of an experimental fertilizer plant, at Muscle Shoals, Ala. Estimated cost $50,000.

**Guano Plant**—Richmond Guano Co., W. E. Barret, Pres., Richmond, Va., contemplates rebuilding its plant at Port Powhatan, near Richmond, recently destroyed by fire with a loss of $100,000.

**Ichthyol Plant**—J. Odd Hamilton et al., c/o Clements Apartments, Burnet, Tex., plans the construction of an ichthyol plant outside the north end city limits of Burnham. Estimated cost $50,000. Owners will purchase machinery and equipment for extracting the ichthyol from rocks, etc.

**Laboratory**—Board of Commissioners, City Hall, Jersey City, N. J., is having plans prepared by J. T. Rowland, Jr., Archt., 30 Journal Sq., Jersey City, N. J., for the construction of a laboratory building at the Medical Centre. Estimated cost $105,000.

**Lacquer Plant**—B. W. Norton Mfg. Co., 3098 10th St., Oakland, Calif., contemplates the construction of a plant. Estimated cost $100,000.

**Linoleum Plant**—Congoleum-Nairn, Inc., F. M. Alken, Chief Engr., 195 Belgrove Drive, Kearny, N. J., is receiving bids for a manufacturing plant at Marcus Hook, Pa. W. W. Lindsay & Co., Inc., Harrison Bldg., Philadelphia, Pa., are engineers. Estimated cost $50,000.

**Mill**—Franklin Process Co., 564 Eddy St., Providence, R. I., had plans prepared by Jenks & Ballou, Archts., 2600 Industrial Trust Bldg., Providence, R. I., for an addition to its mill. Estimated cost between $25,000 and $30,000.

**Paper Mill** — Tennessee Paper Mills, North Chattanooga, Tenn., plan the construction of a 1 story, 50x200 ft. distribution plant.

**Paper Mill** — Waccamew Fibre Farms Co., F. L. Finkenstaldt, Pres., Bolton, N. C., plans the construction of a large paper and pulp mill. Estimated cost $1,300,000. Will apply for loan from Public Works Administration.

**Pencil Plant**—Eberhard Faber Pencil Co., 37 Greenpoint Ave., Brooklyn, N. Y., plans to alter its pencil manufacturing plant at Greenpoint Ave. and West St. Estimated cost $30,000.

**Rayon Plant**—Industrial Rayon Corp., H. S. Rivitz, Pres., West 98th St. and Walford Ave., Cleveland, O., is having plans prepared by Christian, Schwarzenberg & Gaede, Archts., 1836 Euclid Ave., Cleveland, for an addition to its plant. Estimated cost $2,000,000. Maturity of above is contingent upon City of Cleveland constructing private sewer from owner's plant to westerly sewage plant. City to obtain funds from Civil Works Administration.

**Refinery**—Danciger Oil Co., Pledger, Tex., contemplates the construction of a refinery. Estimated cost $85,000.

**Refinery**—P. B. Goodwin, Gladewater, Tex., plans to replace his refinery units recently destroyed by fire. Estimated cost $30,000.

**Refinery**—New Mexico Road Oil Co., c/o Col. A. T. Woods, Midland, Tex., plans to rebuild refinery plant at Dayton, Tex., for the manufacture of oil suitable for road construction. Some new machinery will be required. Estimated cost $75,000.

**Refinery** — North American Petroleum Co., Ltd., W. E. Farley, Pres., Windsor, Ont., Can., plans an oil development and refinery at Edmonton, Alta.

**Refinery**—Pennsylvania Refining Co., Titusville, Pa., will soon receive bids for additions and alterations to its oil refinery, including a complete distillate unit. Estimated cost $50,000.

**Rubber and Metal Products Plant** — Ideal Power Productions, Ltd., K. J. Reaney, Pres., 56 Third Ave., Ottawa, Ont., plans the construction of a 1 story, 60x350 ft. factory for the manufacture of rubber and metal products which require a special bonding process recently perfected. Estimated cost $30,000.

**Sugar Refinery**—National Sugar Refining Co., 56 Ave. and 1st St., Long Island City, N. Y., plans to alter its refinery and install molasses storage tanks. Estimated cost $28,000.

**Zinc Refinery**—Mexican Zinc Corp., San Juan de Sabinas, Mexico, contemplates the construction of a zinc refinery and acid plant near Saltillo, Mexico. Estimated cost $800,000. Mexican Government has granted concession.

**Tire Fabric Plant**—Goodyear Tire & Rubber Co., Akron, Ohio, has acquired the plant formerly used by the Connecticut Cotton Mills at Decatur, Ala., and plans to recondition same for tire fabric plant. Estimated cost $100,000.

**Nickel Plating Shop**—N. Dautuono, Queens Blvd. and 65th St., Winfield, L. I., N. Y., plans the construction of a 1 story, 40x80 ft. nickel plating shop.

**Gold Mine Development**—Lanque Gold Mines, c/o Tech Hughes Gold Mines, Toronto, Ont., Can., plans a gold mine development, including ore concentration mills in the Province of Quebec. Estimated cost $1,000,000.

## CONTRACTS AWARDED

**Chemical Plant**—Mathieson Alkali Works, Inc., 250 Park Ave., New York, N. Y., has purchased a site of 120 acres on Calcasieu Ship Channel, 14 mi. southwest of Lake Charles, La., for the construction of a chemical plant. Contract for design and construction of plant has been awarded to Stone & Webster Engineering Corp., 90 Broad St., New York, N. Y., and Syracuse, N. Y. Estimated cost to exceed $5,000,000.

**Chemical Plant**—Merck & Co., Rahway, N. J., and 161 6th Ave., New York, N. Y., plans to alter and construct two 1 story additions to its plant at Rahway, N. J. Contract has been awarded to Salmond-Schrimshaw Construction Co., Summit Pl., Newark, N. J. Estimated cost, $30,000.

**Chemical Plant**—Monsanto Chemical Co., 1724 South 2nd St., St. Louis, Mo., awarded contract for service building for chemical plant to J. I. Gedney Co., 1461 Hall St., East St. Louis, Ill.

**Chemical Plant** — Shell Chemical Co., Shell Bldg., San Francisco, Calif., awarded contract for 1 story, 65x122 ft. combination processing room and warehouse, to Lindgren-Swinerton, Inc., 225 Bush St., San Francisco, Calif. Estimated cost $12,000 excluding equipment.

**Chemical Plant** — Wallerstein Co., Inc., M. Wallerstein, Pres., 171 Madison Ave., New York, N. Y., awarded contract for altering and constructing addition to chemical plant at Mariners Harbor near Bayonne Bridge, S. I., to Wigton-Abbott Corp., 143 Liberty St., New York, N. Y. Estimated cost $35,000.

**Factory** — Dupont Viscoloid Co., Inc., 630 Schuyler Ave., Kearney, N. J., awarded contract for additions to factory, to Salmond-Scrimshaw & Co., 526 Elm St., Kearney, N. J. Estimated cost $29,000.

**Gasoline Absorption Plant**—O. C. Field Gasoline Corp., 111 West 7th St., Los Angeles, Calif., awarded contract for gasoline absorption plant at 20th St. and Acacia Ave., Huntington Beach, Calif., to Fluor Corp., 909 East 59th St., Los Angeles. Estimated cost $100,000. New equipmen will be required.

**Paper Plant**—Pioneer Paper Co., 5500 South Alameda St., Los Angeles, Calif., awarded contract for 48x500 ft. machine room, 49x72 ft. beater room and two warehouses at plant, to W. P. Neil Co., 4814 Loma Vista St., Los Angeles. Estimated cost $31,500.

**Rosin Factory**—Robert Rauh, Inc., 488 Frelinghuysen Ave., Newark, N. J., awarded contract for addition to rosin factory to Eustice Bros., 877 Frelinghuysen Ave., Newark. Estimated cost $29,000.

**Factory**—Western Waxed Paper Co., 63rd and Green Sts., Emeryville, Calif., awarded contract for 1 story addition to factory to A. T. Beckett, 224 Scenic Ave., Piedmont.

**Ore Mill**—American Consolidated Tin Mines, 120 Liberty St., New York, N. Y., are having plans prepared by U. S. James, Engr., c/o James Ore Concentrator, 35 Runyon St., Newark, N. J., for an ore mill and development in the vicinity of Lincolnton, N. C. Work will be done by day labor and separate contracts, under supervision of engineer. Estimated cost $100,000.

**Gas Storage Facilities**—City, Palo Alto, Calif., having surveys made for additional gas storage facilities and bustane generator. Work will be under jurisdiction of Municipal Utility Department under supervision of L. H. Anderson, Manager. Estimated cost $25,000.


***Greatest product uniformity and operating economy come from a co-ordinated system of temperature control. Assure this advantage for your product and plant with Taylor Service***

THE maker of paper and the brewer of beer have one thing in common, at least. The best pulp and the finest-flavored brew depend on exact control of temperature. This accurate control is vital in producing the best of *any* product. And it's the control that Taylor Indicating, Recording and Regulating Instruments supply to every industry.

The use of a few individual temperature and pressure instruments does not always mean that you have the control needed to make a uniformly high quality product.

Our experience of 80 years in studying industry's needs has proved that real control comes—NOT from purchase of individual instruments, but from application of control to a plant as a whole. This may mean the use of two or three more instruments—or installation of a complete Taylor Control Plan built into the manufacturing processes.

We offer a special Taylor Service today designed to supply a plant's complete needs for Temperature Control, and NOT merely to try to sell individual Taylor instruments.

### *Available Service*

This Service is for small plants as well as large. It starts with a thorough survey and analysis of your present plant operation, and your existing method of controlling temperature and pressure. It covers specification of the proper Taylor Instruments and includes recommendations for the most accurate and efficient plant control by Taylor engineers who know every type of instrument application. Finally, this Service helps in the installation of the temperature control and its proper co-ordination with manufacturing processes.

Taylor Service is available now. It is easy to start it working for you. Why not talk it over with a Taylor Representative? His call places you under no obligation. It costs only the price of a stamp on an envelope addressed to Taylor Instrument Companies, Rochester, New York.

NRA MEMBER U.S. WE DO OUR PART

**SPECIAL TAYLOR NEWS FLASH**

All Taylor Temperature and Pressure Recorders and Recording Regulators are now being shipped with a newly designed die-cast case. The instrument mechanism inside contains distinct improvements designed to give industry the most modern, accurate and durable temperature and pressure control equipment. More detailed information on these new Taylor Instruments later. Meanwhile, if you are using them, enjoy their fine accuracy and positive operation.

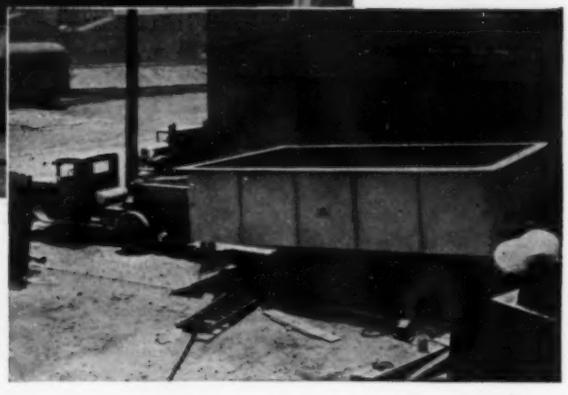
† Tycos **Taylor**

Indicating | Recording • Controlling

**TEMPERATURE *and* PRESSURE INSTRUMENTS**

† The name Taylor now identifies our complete line of products including Tycos instruments.

Here is a one-piece tank lined by "U. S." measuring 20 feet and 4 inches in length, 13 feet and 9 inches in width and 5 feet in depth.



# RUBBER LININGS for TANKS, CARS, RACKS, etc.

## "U. S." RUBBER LININGS CAN BE APPLIED TO METAL OR WOOD

**Wherever acids and corrosives must be handled, stored, or transported, "U. S." Rubber Lined Tanks, Shipping Containers, Tank Cars, Dippers, Buckets, Plating Equipment, etc., will prove most economical.**

**Many progressive industries are calling on "U. S." to study their acid handling problems. In their effort to lower their process costs they recognize in "U. S.", as the world's largest producer of rubber, the logical authority on the subject of rubber linings.**

**Why not ask a "U. S." engineer to make a corrosive study in your plant? He will give you the specific savings you can make—he will recommend exactly the right lining for your job, a lining compounded specifically to your operating conditions. There won't be the slightest obligation on your part for this service.**

**Why not write today to the "U. S." Branch nearest you or, if you prefer, direct to the New York address given below.**

NRA MEMBER U.S. WE DO OUR PART

## United States Rubber Company

**1790 BROADWAY (US) NEW YORK CITY**

**BRANCHES IN ALL INDUSTRIAL CENTERS**

**"U. S." RUBBER PRODUCTS GIVE THAT EXTRA SERVICE**

# DIBUTYL ETHER C.S.C.

## A New and Interesting High-Boiling Ether

DIBUTYL Ether C.S.C. is a high-boiling, chemically stable, water-white liquid possessing a mild ethereal odor. » » Dibutyl Ether C.S.C. is not miscible with water in any proportion. It is miscible with most common organic solvents, and is itself a good solvent for a wide variety of substances including organic acids and esters, many resins and gums, essential and vegetable oils. It is not a solvent, however, for orange shellac, cellulose acetate, or cellulose nitrate. White beeswax and Carnauba wax are only slightly soluble in Dibutyl Ether C.S.C. at room temperature, but become very soluble in it at somewhat higher temperatures.

These rather unusual selective solvent properties indicate that Dibutyl Ether C.S.C. will be found useful as an extractant, precipitant, or refining agent in the preparation of a variety of materials such as essential oils, petroleum lubricating oils, flavoring materials, perfumes, waxes, and resins. Another promising use for this ether is as a solvent medium in chemical synthesis; its chemical stability and relatively low volatility recommend it for this purpose.

•

PROPERTIES

COLOR: Water-white

ODOR: Mild, ethereal

DISTILLATION RANGE: 130°C. to 145°C.

FLASH POINT: About 25°C.

ACIDITY (as acetic): 0.07%

SOLUBILITY IN WATER: Dibutyl ether and water are mutually insoluble and immiscible

WEIGHT PER U. S. GALLON: 6.45 pounds at 68°F.

**COMMERCIAL SOLVENTS CORPORATION**

230 PARK AVENUE NEW YORK, N.Y.

PLANTS . . . TERRE HAUTE, INDIANA, and PEORIA, ILLINOIS

WAREHOUSES

Boston, Mass. Chicago, Ill. Cleveland, Ohio Detroit, Mich.
Los Angeles, Calif. Louisville, Ky. Newark, N. J.
Philadelphia, Pa. St. Louis, Mo.
San Francisco, Calif.

**CHEMICALS FROM CORN**

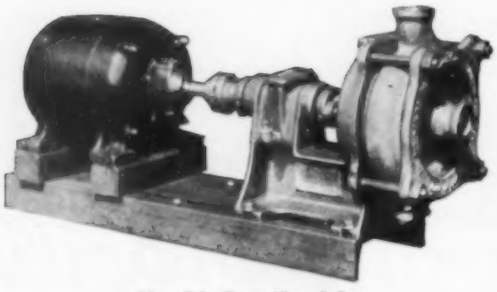
**PRODUCTS**

ACETONE • BUTANOL • BUTYL LACTATE
BUTYL STEARATE
BUTYL ACETATE • DIACETONE
BUTYL ACETYL RICINOLEATE • BUTALYDE
DIBUTYL PHTHALATE • METHANOL
METHYLAMINES

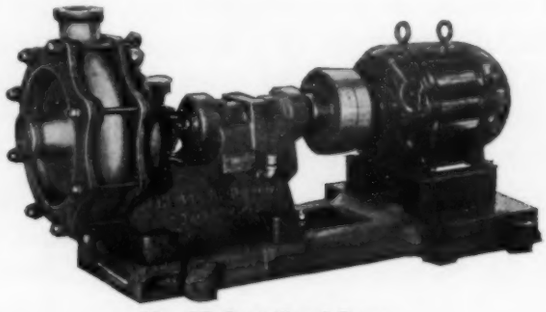
# Corrosion-resisting Pumps for any Acid or Caustic Solution

## General Specifications

Casing, impeller and all other parts touched by the liquid are made of the most suitable alloy. The impeller is the closed type with integral cast protecting sleeve through stuffing box; replaceable, ring-oiling, babbitted bearings; cast iron base, with bearing housing and volute clamping yoke cast integral; either belt or direct drive.



No. 2A Centrifugal Pump



No. 2E Centrifugal Pump

**Series 2A Centrifugal Pump**
**Suction 1″, Discharge 1″**

CAPACITY

2½ g.p.m. at 25 ft. head, 0.3 h.p.
25 g.p.m. at 5 ft. head, 0.4 h.p.

**Series 2D* Centrifugal Pump**
**Suction 2″, Discharge 1½″**

CAPACITY

120 g.p.m. at 20 ft. head, 3.75 h.p.
10 g.p.m. at 60 ft. head, 1.5 h.p.

**Series 3D Centrifugal Pump**
**Suction 2″, Discharge 1½″**

CAPACITY

147 g.p.m. at 35 ft. head, 4.25 h.p.
10 g.p.m. at 79 ft. head, 2 h.p.

**Series 2E* Centrifugal Pump**
**Suction 2″, Discharge 2″**

CAPACITY

160 g.p.m. at 70 ft. head, 6.5 h.p.
20 g.p.m. at 98 ft. head, 3 h.p.

**Series 2G* Centrifugal Pump**
**Suction 3″, Discharge 2″**

CAPACITY

270 g.p.m. at 80 ft. head, 11 h.p.
20 g.p.m. at 120 ft. head, 5 h.p.

**Series 2J Centrifugal Pump**
**Suction 4″, Discharge 3″**

CAPACITY

400 g.p.m. at 70 ft. head
40 g.p.m. at 120 ft. head
(Available March 1934)

NRA MEMBER U.S. WE DO OUR PART

*Also available as self-priming pumps. Capacity figures and horsepower requirements based on solutions of Sp. Gr. 1.0, of same viscosity as water.

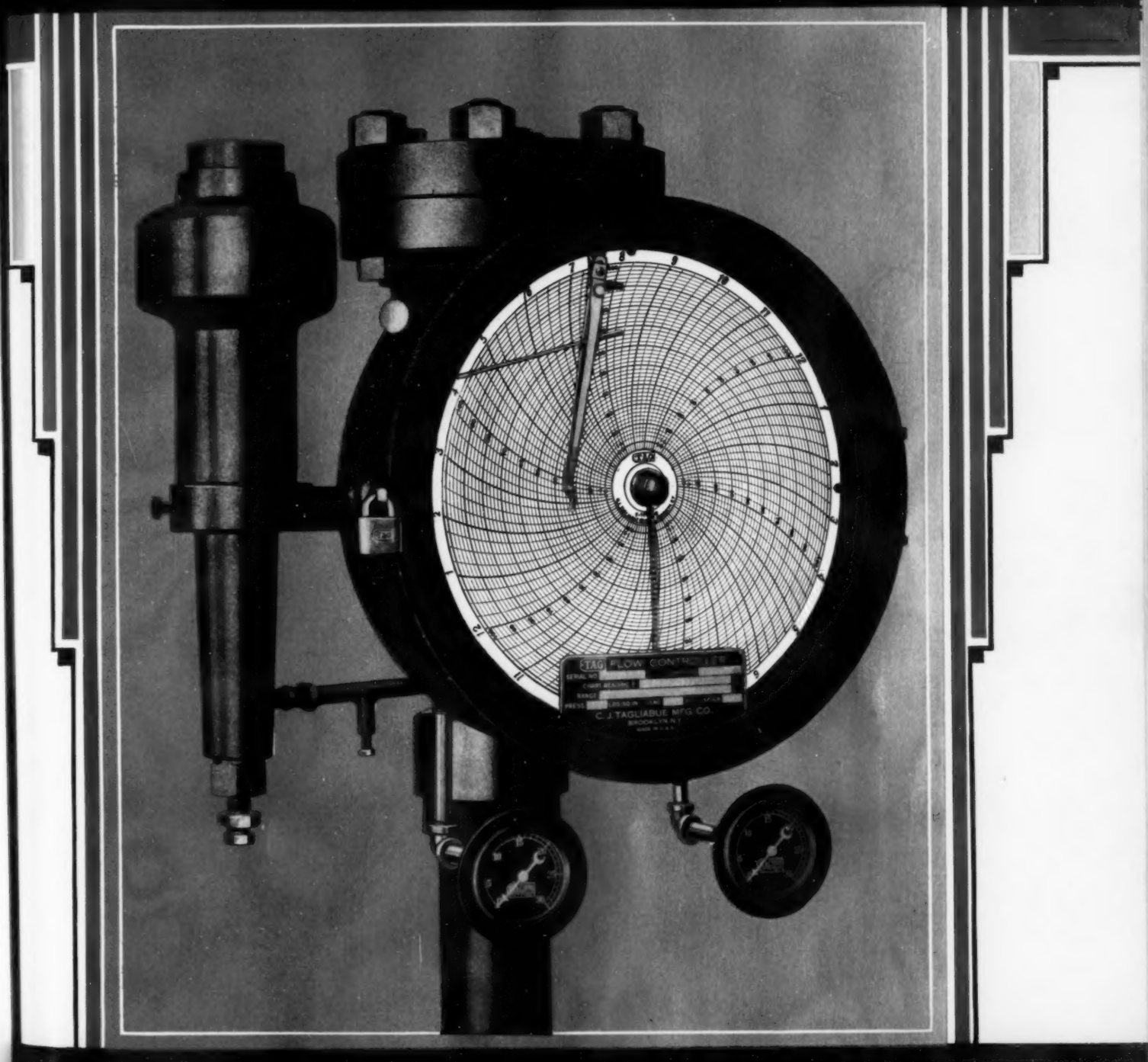
## THE DURIRON COMPANY, Inc.

424 N. Findlay St., Dayton, Ohio

*Manufacturers of Chemical Equipment in*

DURIRON—DURICHLOR—DURIMET—DURCO ALLOY STEELS—ALCUMITE

# ONLY TAG GIVES TO YOU . . .




# The Ideal Manometer

**Combined With**

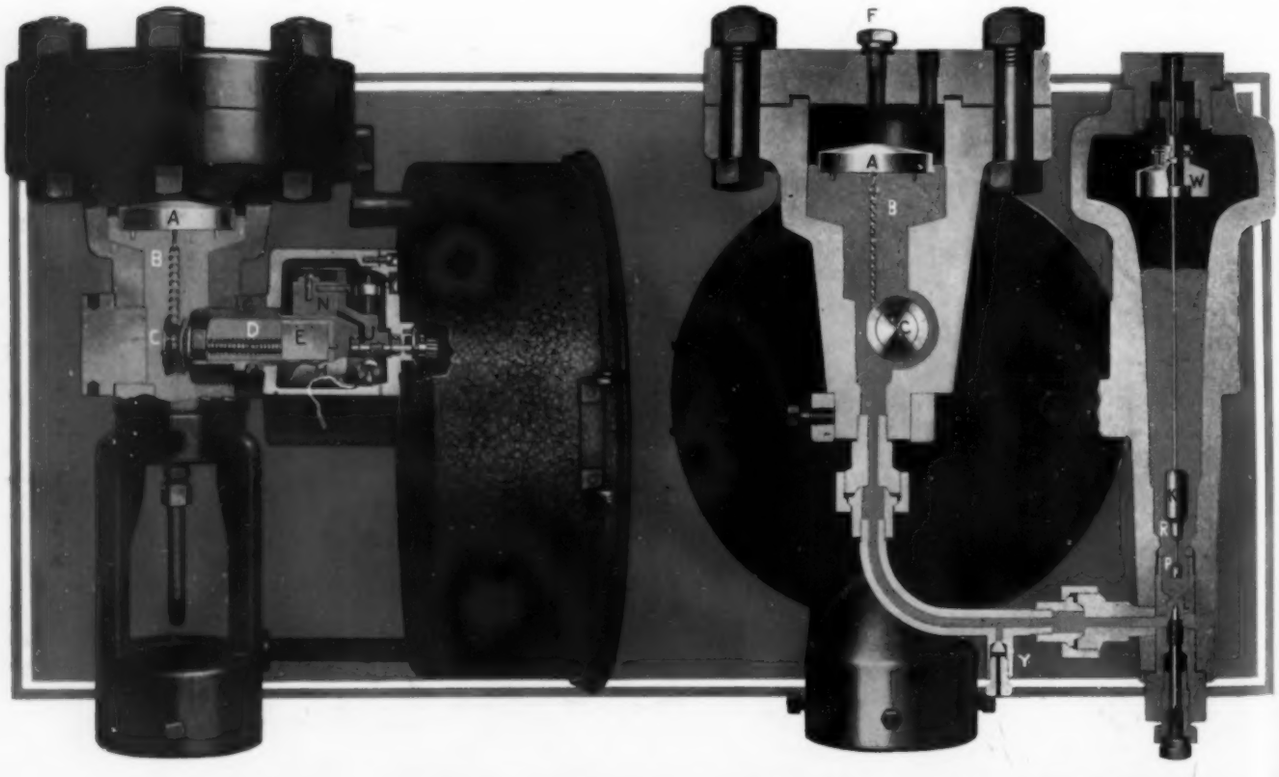
# A Super Controller

# TAG Magnetic Clutch

# The Ideal Manometer


**THE O.K. of the Oil Industry is never lightly bestowed. TAG Magnetic Clutch Flow Instruments have won it. By their performance on hundreds of installations they have earned from engineers and operating men the superlative endorsement . . . "TAG is the ideal instrument for our work." Why is TAG supplanting the old pressure-tight bearing design?**

1. **Safety First**—No stuffing box to leak or bind . . . 2500 pounds Standard Construction . . . Forged steel manometer.
2. **Corrosion-Proof**—No stuffing box permits the submerging of all working parts in mercury during operation.
3. **Better Accuracy**—No stuffing box, instead magnetic clutch, which is virtually frictionless REGARDLESS of operating pressure.
4. **Less Maintenance**—No stuffing box, hence no lubricator to service . . . Longer life because of corrosion-proof design.
5. **Less Installation Expense**—No sealing chambers required for corrosive fluids . . . Universal mounting for flush, wall or pipe stand.




## C. J. TAGLIABUE MFG. CO.

# TAG Damplifier (Damped Amplification)

# A Super Controller

**TAG** who pioneered automatic control in industry, sums up years of experience in the *TAG Damplifier*. From the featherweight flapper to the familiar TAG Ball Air Valve it is made up of time-tested elements, simply and logically arranged. And its unique *Damped Amplification* gives you the ultimate in an air-operated controller.

1. **Straight Line Control**—No "hunting" . . . Perfectly balanced control action . . . *Damped Amplification* prevents any over-control tendency.

2. **No Overswings Coming into Control**—After a decided change in conditions causing a considerable departure of control from setting point and also when operator resets controller at a new point, controller will smoothly pick up setting without a series of overswing cycles.

3. **Unaffected by Load Changes**—The *TAG Damplifier* can maintain the diaphragm valve in any position between open and shut while maintaining the setting point unchanged.

4. **100% Automatic**—Naturally the *TAG Damplifier* needs no assistance from hand regulation of by-pass . . . It is competent to take complete charge of the job without help.

5. **Unaffected by Air Supply Variations**—Air supply pressure can vary (down to actual air pressure on diaphragm valve) without influencing control behavior.

6. **Outside Setting Pointer Adjustment**—Adjusting knob for setting pointer is outside so that door need not be opened when operator wishes to change control point.

7. **Uniform Chart Divisions**—Volumeter manometer with parabolic curved cross-section gives uniform chart in units of flow, assuring uniform control accuracy and action throughout range . . . Conventional straight side manometer optional.

***In Your Modernization Program, Use Modern Flow Instruments***

**Park and Nostrand Aves., Brooklyn, N.Y.**

# ...and the TAG Friction-Free Valve Finishes the job right

THE business end of a control system is the diaphragm valve. The TAG Friction-Free Valve reduces friction to the minimum. The stroke of the small diameter spindle through the stuffing box is perfectly guided by the two roller bearing assemblies through which the large diameter, upper portion of the spindle, passes. Other features are the enclosed spring and diaphragm chambers, the convenient adjustments and the position indicator. The valve itself is the high lift V-port type.

**TAG Line**

**Controllers**
Temperature
Pressure
Level
Flow

**Recorders**
Temperature
Pressure
Level
Flow

**Thermometers**
Dial-Indicating
Laboratory
Industrial

**Pyrometers**
Controlling
Indicating
Recording

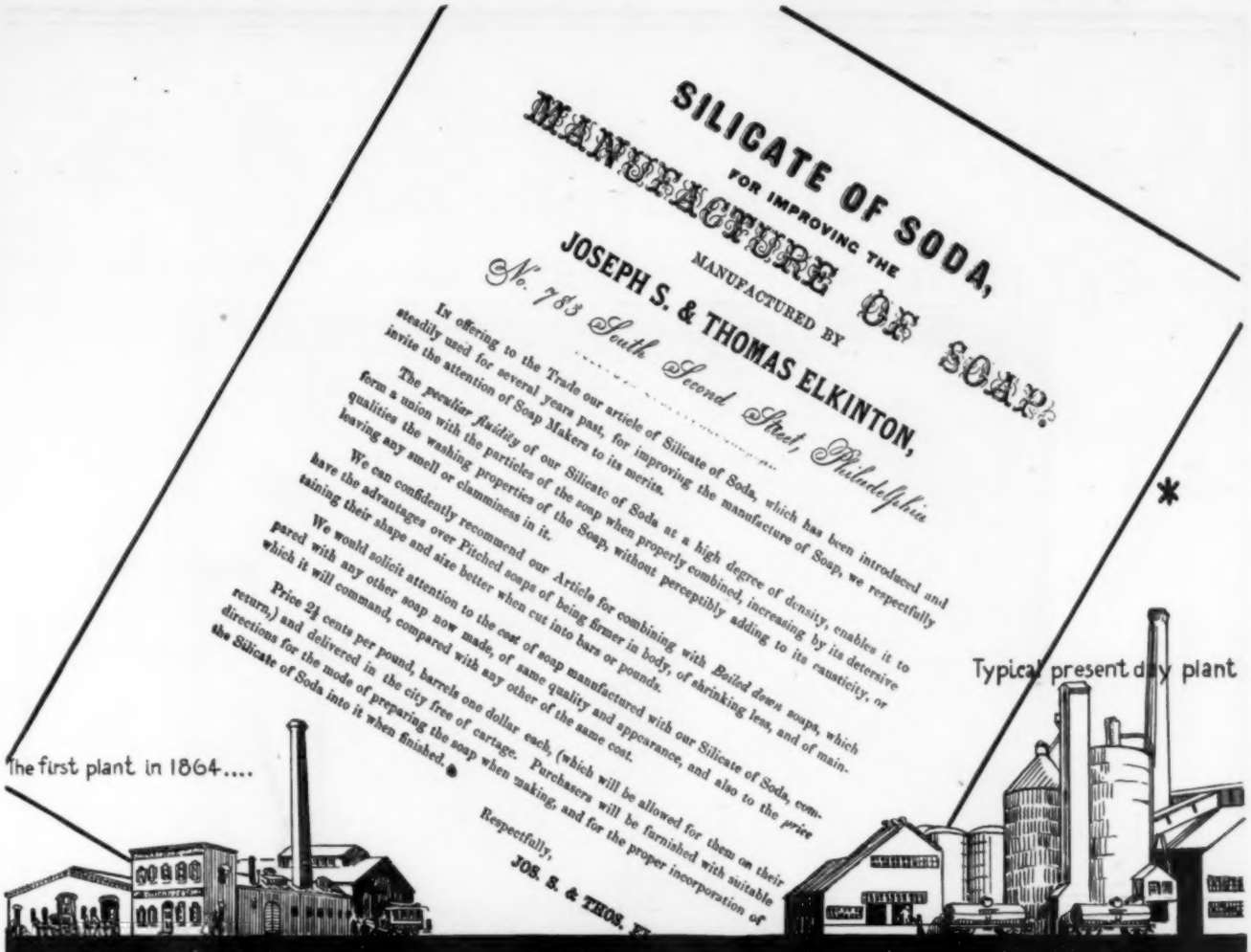
**Oil Testing Instruments**

**Gas Analysis Recorders**

**Vacuum Gages**


**C. J. TAGLIABUE MFG. CO.**
**Park and Nostrand Avenues**
**Brooklyn, N. Y.**

**MAIL COUPON TODAY**




## *Magic Symbols of Usefulness and their background . . .*

LABORATORY and industry have long known P. Q. Silicates for their useful service and economy and P. Q. Co. for its fundamental silicate knowledge and liberal co-operation.

From early beginnings, as you observe from an 1864 advertisement, the tradition has been to sell more than just silicate of soda. A useful consultative service has been incorporated in our product, and every reasonable effort is made to help the consumer adapt it to his needs.

P. Q. Silicate of Soda from its first application in household soaps to the most recent use in concrete paint has required close study to adapt the unique properties to industry's varied needs. The experience of three-fourths of a century is at your disposal.

If you use silicate or merely suspect you can, consult P. Q. Headquarters.

*First printed advertisement devoted entirely to silicate of soda, published just prior to the adoption of the silicate company name—Philadelphia Quartz Company.

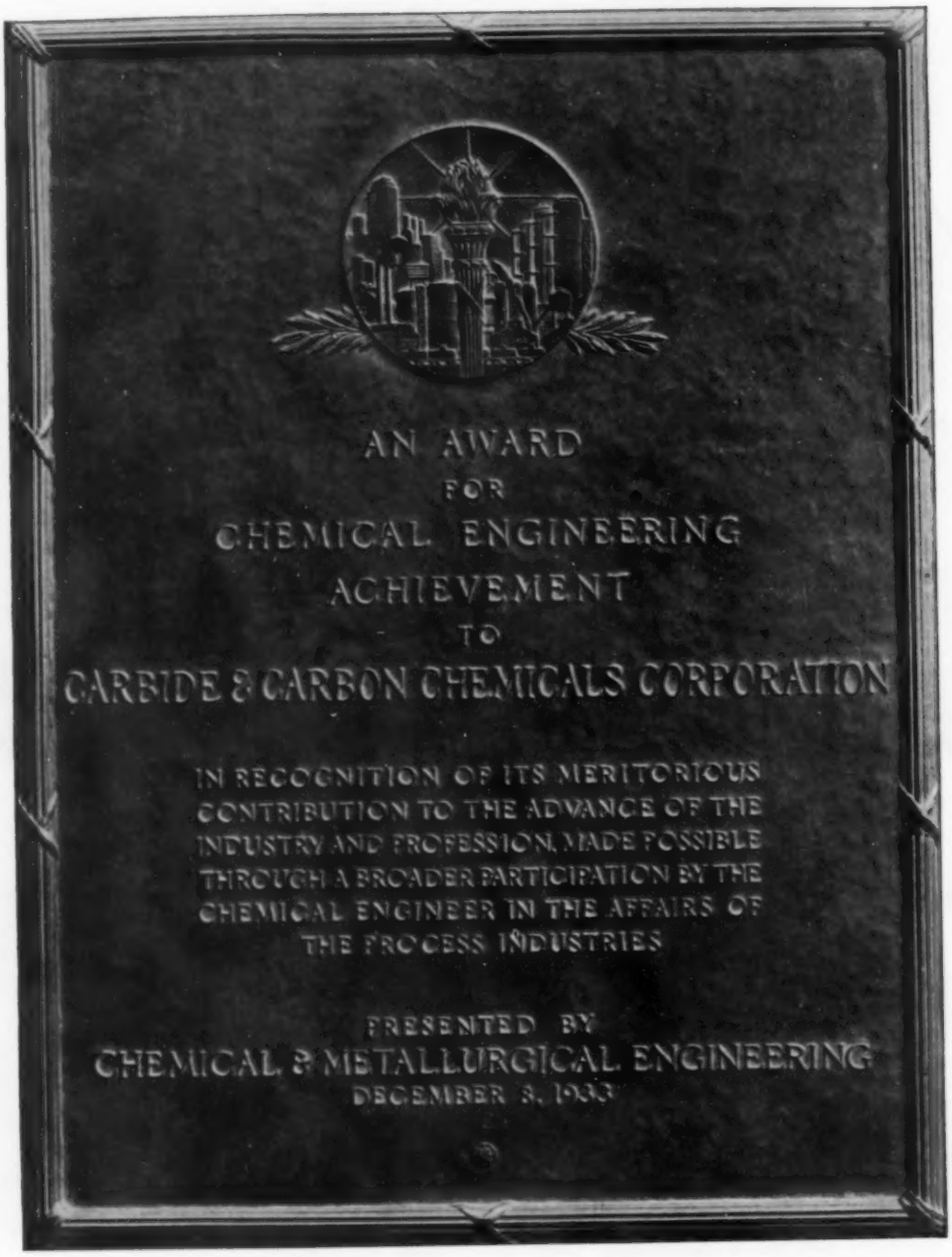
**PHILADELPHIA QUARTZ COMPANY** ESTABLISHED 1831

*General Office and Laboratory:* 125 S. Third St., Philadelphia, Penna.
Chicago Sales Office: 205 W. Wacker Drive. Stocks in 66 cities.
Sold in Canada by NATIONAL SILICATES LTD., Brantford, Ontario.

WORKS: Chester, Pa. · Baltimore, Md. · Anderson, Ind. · Gardenville, N. Y. · Kansas City, Kans. · Rahway, N. J. · St. Louis, Mo. · Utica, Ill.

PQ REG. U.S. PAT. OFF.

**TO DO THE JOB BETTER OR AT LESS COST**


AN AWARD
FOR
CHEMICAL ENGINEERING
ACHIEVEMENT
TO
CARBIDE & CARBON CHEMICALS CORPORATION
IN RECOGNITION OF ITS MERITORIOUS
CONTRIBUTION TO THE ADVANCE OF THE
INDUSTRY AND PROFESSION, MADE POSSIBLE
THROUGH A BROADER PARTICIPATION BY THE
CHEMICAL ENGINEER IN THE AFFAIRS OF
THE PROCESS INDUSTRIES
PRESENTED BY
CHEMICAL & METALLURGICAL ENGINEERING
DECEMBER 3, 1933

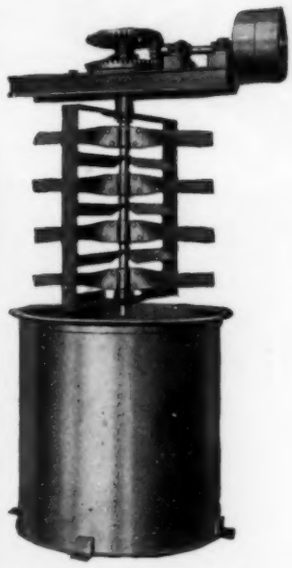
# The Answer To Greater Operating Profit is MODERNIZED PRODUCTION

Power savings — reduced labor costs—simplified methods — uniform quality of product — minimized waste —these are some of the questions that manufacturers used to mull over and think about but seldom found time to act upon.

They have now become matters of major importance and rightly so. They do mean the differenct between profit and loss. And their only answer is modernized equipment. Firms that have replaced obsolete and cumbersome machinery with modern, efficient equipment are enjoying greater profit even though their volume of orders is noticeably lower.

***Modernization of Your Plant Needn't Worry You***

Simply place your problems in the care of Robinson "UNIQUE" Engineers. They will gladly submit a "workable" plan for your consideration without obligation to you.



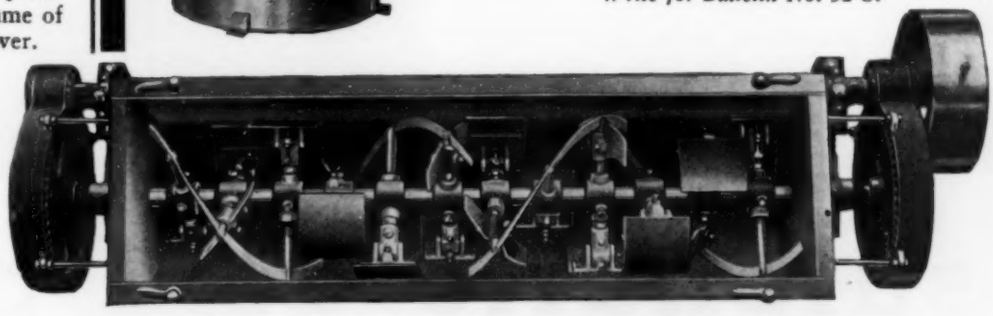
## MIXERS

UNIQUE and GARDNER Mixers answer every problem of mixing dry, damp, liquid, free-flowing or sluggish materials. We are constantly making successful installations for the mixing of all types of products—recommending and furnishing standard machines where they fill the bill—but often designing and building special mixers where standard types have failed to produce the desired results.

*Left:* VERTICAL LIQUID MIXER for dissolving cellulose products, and used extensively for preparing softeners, emulsions, size mixings, finishing mixings, pastes, soap, paint, shoe dressings, greases, rubber solutions and cements, etc.

*Below:* MIXER WITH PATENTED TROWEL MIXING BLADES: The only Mixer that will create an intimate mix where one or more of the ingredients have a tendency to ball up or cause the bulk to mass or glomerate. The trowel type blades and conveyor paddle combination insure a thorough disintegration and uniform blend. May be fabricated of special corrosion-resistant materials.

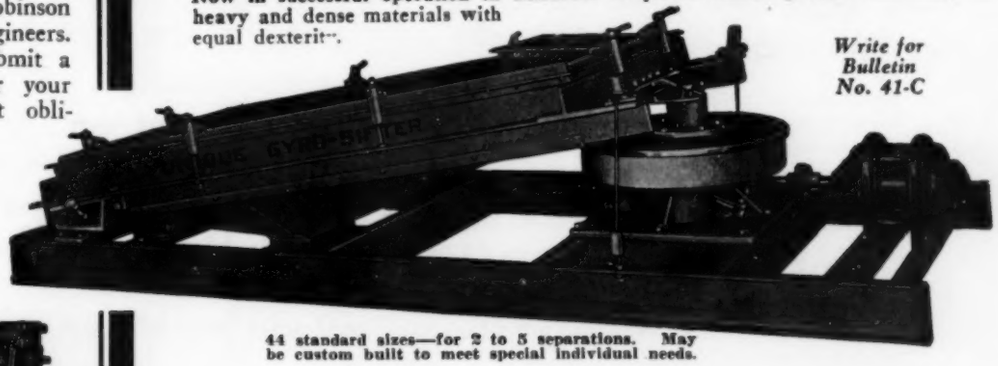
***Write for Bulletin No. 32-C.***



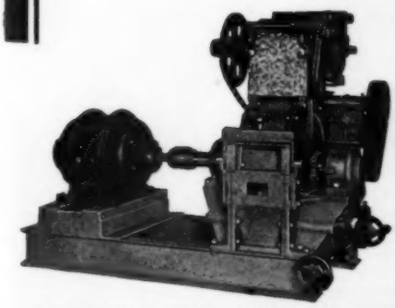
## GYRO-SIFTER

**For production sifting, separating and grading of all types of materials where absolute uniformity of "size" and economical operation are paramount requisites. Now in successful operation in hundreds of plants handling light and fluffy or heavy and dense materials with equal dexterity.**

***Write for Bulletin No. 41-C***



**44 standard sizes—for 2 to 5 separations. May be custom built to meet special individual needs.**



**SCREEN TYPE PULVERIZER**

**A powerful, compact, efficient mill adjustable for various degrees of fineness. Results are certain—ALWAYS. Used extensively throughout the process industries.**

## WE MANUFACTURE

CRUSHERS, GRINDERS, PULVERIZERS, SIFTERS, MIXERS, ELEVATORS, CONVEYORS AND SPECIAL ITEMS and combine any number of machines and items into compact, convenient and efficient units.

# ROBINSON MFG. CO.

71 PAINTER ST. — MUNCY, PA.

***Complete process equipment—PLUS—a helpful engineering and advisory service.***

*Milk Truck Tank made from IngOclad. Built by Alloy Products Corp., Waukesha, Wis.*

# Now You Can Afford to Use STAINLESS STEEL

## *to protect and improve your Product!*

IngOclad removes all price barriers to the liberal use of stainless steel. Industry after industry is turning to this new stainless-clad steel—not only because of the marked savings on original equipment, but because maintenance is much lower—better sanitation is assured—costly damages from rust and corrosion are eliminated, and the manufactured product is constantly protected against discoloration and change of character, flavor or odor.

**INGOCLAD**

*Trade-Mark Reg.*

gives you the protection of finest stainless steel on its exposed or contact side and the economy of mild carbon steel on the other side. The two metals are inseparably bonded together because the union begins when the metals are poured to form the ingot. No intermediate or binder ply is needed.


### A Few of the Many Industries

where IngOclad is already being successfully used:

Chemical Industry
Food Industry
Soap Industry
Drug Industry
Paper Industry
Dairy Industry
Brewing Industry
Distilling Industry
Wine Industry
Plumbing Industry
Automotive Industry
Kitchen Utensil Industry

### Fabricators . . . Please Note

IngOclad may be formed, drawn, spun, beaded, brazed, soldered and fabricated with practically the same equipment used in handling low carbon steels. We have developed simplified welding practice in handling IngOclad which is available on request.

*Ask for quotations on IngOclad. Our Engineers are at your service*

**INGERSOLL STEEL & DISC CO.**

(A DIVISION OF BORG-WARNER CORPORATION)

*Specialists in High Carbon, Alloy and High Speed Steel and Stainless-Clad Sheets*

310 SOUTH MICHIGAN AVE., CHICAGO, ILL.

Plants: Chicago, Illinois and New Castle, Indiana

*Pacific Coast Representative:* SIMONDS MACHINERY COMPANY
816 Folsom St., San Francisco 522 East 4th St., Los Angeles

*Eastern Representative:* H. BOKER & CO., Inc.
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REG. U.S. PAT. OFF.
TONCAN
COPPER
MO·LYB·DEN·UM
IRON PIPE

# FIGHTS SALT CORROSION


ALONG the cat-walk leading from the tanker at anchor to the bulk plant on shore stretch lines of Toncan Iron Pipe. Why? Because it is universal experience that where ferrous metal is subjected to the action of salt air or salt water, the resistance of Toncan Iron to salt corrosion makes its use practically imperative. That's why Toncan Iron Pipe is found aboard the sister ships, T.S.S. Washington and Manhattan, and in any number of other ocean-going vessels, including freighters, tankers, tug boats, dredges and yachts.

Toncan Iron is an alloy of refined iron, copper and molybdenum. Among the ferrous metals, its resistance to the elements that cause rapid failure of less hardy materials is surpassed only by that of the much more costly stainless alloys. Its resistance is not confined to the surface of the metal or to segregated areas—it is uniform throughout the entire area and thickness.

All of which is just another way of saying that—where salt corrosion is encountered, take no chances. Use the pipe—or the sheet metal—or the culvert—or the boiler tube that will give you the best service for your dollar—use Toncan Iron.

**REPUBLIC STEEL CORPORATION**
GENERAL OFFICES — YOUNGSTOWN, OHIO

# LOUISVILLE DRYER PERFORMS ANOTHER EFFECTIVE "RECOVERY ACT".....

WITH all respect, and highest hopes, for the N.I.R.A., it is also true that "God helps him who helps himself."

The figures at the right tell the story of one typical American manufacturer who helped himself in a substantial way by tearing out an old drying system and replacing it with a *Louisville* Dryer.

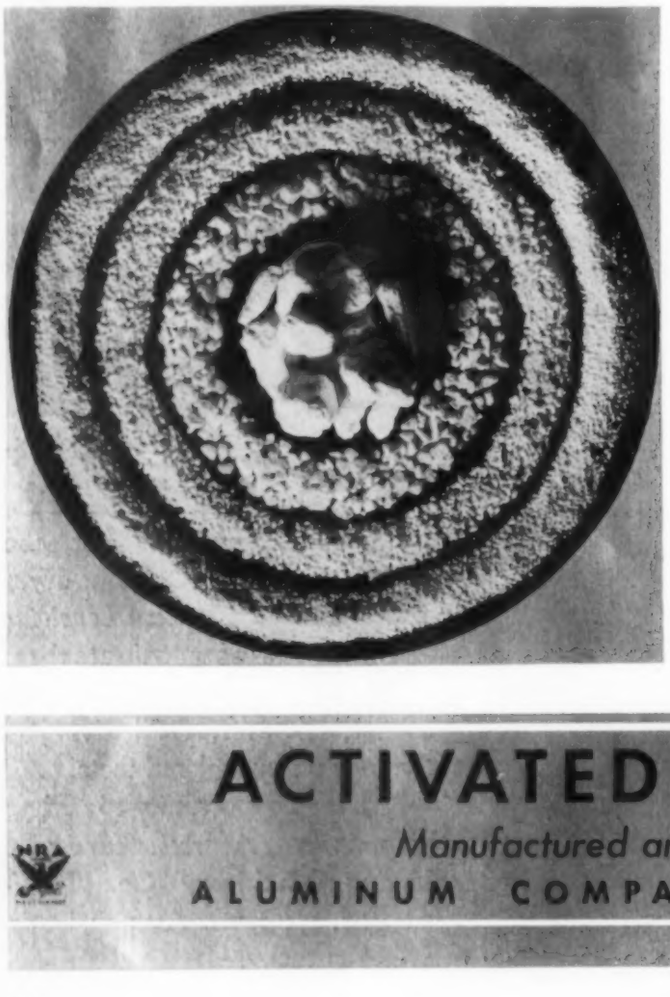
*As a result, he has increased his net annual profit by $23,485, and is earning an 156% net annual return on the investment.*

| PREVIOUS SYSTEM (Batch Press and Tray Dryer) | |
|---|---|
| Tons wet material | 30,000 |
| Tons dried product | 720 |
| Value at 8c lb. | $115,200 |
| All drying costs | 18,720 |
| Net annual revenue | $96,480 |
| **PRESENT SYSTEM (Louisville Rotary Dryer Plant)** | |
| Tons wet material | 30,000 |
| Tons dried product | 780 |
| Value at 8c lb. | $124,800 |
| All drying costs | 4,835 |
| Net annual revenue | $119,965 |
| INCREASE IN NET ANNUAL RETURN | $23,485 |
| INSTALLED VALUE, NEW DRYING PLANT | $15,000 |

This case, outstanding as it seems, is NOT unusual. In fact, the chances are that unless your dryer is a comparatively recent *Lousiville* machine, we can approximate these results *for you*. Whether we can or cannot, however, we'll give you the true and uncolored facts. All we ask is an opportunity to analyze your needs. *Address:* Louisville Drying Machinery Co., Incorporated, 451 Baxter Avenue, Louisville, Kentucky.

# *A new "Unit Process"—* Industrial Adsorption with **ACTIVATED ALUMINA**

*Activated Alumina* completely and selectively adsorbs moisture from gases, vapors, liquids and solids. It is chemically inert and can be repeatedly reactivated in place without deterioration. It will adsorb moisture from air and gases at 100% efficiency (dew points below –60°C.) *Activated Alumina* will adsorb moisture at 100% efficiency until it has increased in weight from 12 to 14% and will thenceforth continue to adsorb at lower efficiencies until a 20% to 25% weight increase has been reached. When saturated, it may be reactivated by aspirating heated gases thru the Activated Alumina or by radiating heat from an electrical element or from hot oil or steam coils. After reactivation and cooling, the adsorbent is again ready for service.



*Activated Alumina* has many special applications in the conditioning and refining of gases, liquids and solids.

*Activated Alumina* with its large internal area and high porosity is useful as a catalyst carrier. As a dehydrating catalyst it is now available in granular form. Available also in various sizes from fine granules up to 1½" lumps, the latter are particularly suitable for towers and converters.

*Activated Alumina* is particularly applicable to industrial problems involving dehydration, separation, purification, conditioning, reclamation, refining and catalysis. Applications embrace many uses, typical examples of which follow:

Drying Gases, Dehydrating Liquids, Drying Refrigerants, Air Conditioning, Household and Industrial, Clarification of Liquids, Solvent Recovery, Gas Masks and Canisters, Removal of Oil Vapor from Compressed Gases, Drying Air for Blast Furnaces, Cupolas, Converters, etc., Catalyst and Catalyst Carrier, Conditioning of Warehouse Atmospheres, Complete Drying of Air, Selective Gas Adsorption and Purification and Deodorizing of Gases, Liquids and Solids.

These applications are verified and explained in greater detail in our brochure "Activated Alumina". A copy may be obtained by addressing ALUMINUM COMPANY *of* AMERICA; 1851 Gulf Building, PITTSBURGH, PENNA.

**ACTIVATED ALUMINA**

*Manufactured and sold only by*

**ALUMINUM COMPANY OF AMERICA**

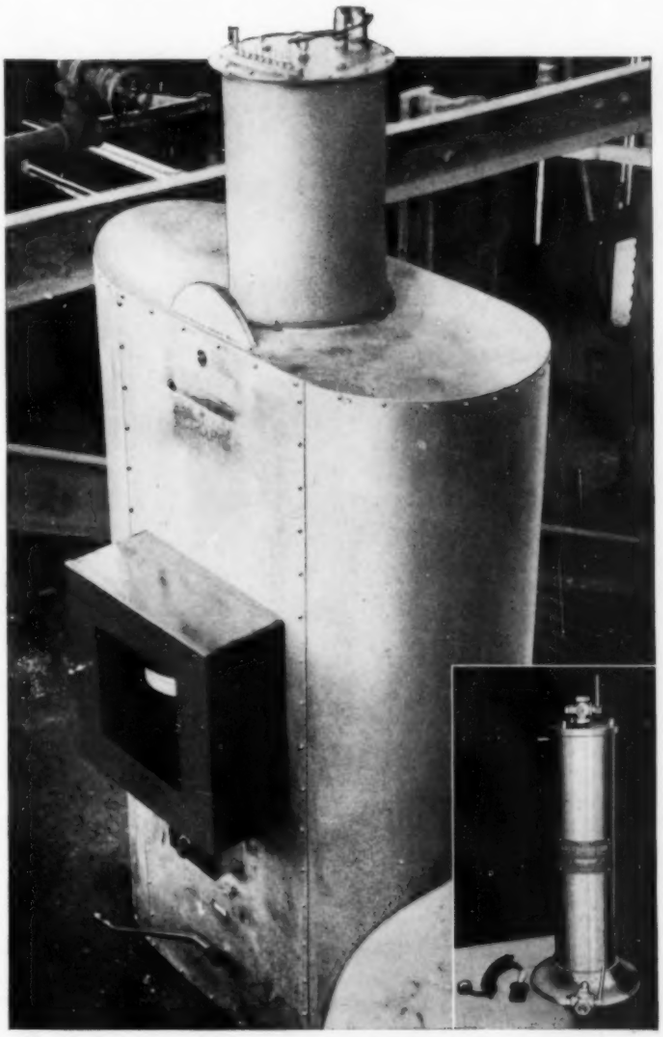
# *Announcing . . .*
# The LECTRODRYER
# "Activated Alumina System"
# —a new practical adsorption unit

For the practical utilization of *Activated Alumina* in industry, the LECTRODRYER has been developed after intensive experimental and plant investigation. The LECTRODRYER, for continuous dehydration or gas adsorption, is usually furnished in multiple units of two or more. When a unit has become saturated with moisture, it is cut out of the line by the movement of a single lever which simultaneously cuts in a fresh adsorber. The spent adsorber may be reactivated in the interval and made ready for service again. The apparatus is electrically operated, although it can be furnished for reactivation by gas, oil or steam. Valves and electrical connections are so interlocked that no mistake can be made in cutting an adsorber out of service, reactivating it, cooling and returning it to service again.

LECTRODRYERS are built for operation at approximately atmospheric pressure, for operation at pressures of from 90 to 125 pounds per square inch and on special order for higher pressures. Standard sizes are available in both single and multiple units.

The Laboratory LECTRODRYER (smallest standard size) has a capacity of 100 cubic feet of gas per hour and may be reactivated by plugging into any 110-volt light socket. Other standard LECTRODRYERS are designed to handle 500, 1000, 2500, 6000 and 10,000 cubic feet or more of gas per hour. Special units also are available which may include self-contained circulating systems, precoolers, dust and oil vapor filters and are equipped for manually or automatically maintaining any desired humidity. Equipment is also offered for practical performance of special adsorption processes.

Write for details of the standard and special LECTRODRYERS, as well as a descriptive pamphlet.



LECTRODRYER plant equipment and Laboratory LECTRODRYER. The driest air of the Sahara Desert is "wet" in comparison with the air coming from even the smallest standard LECTRODRYER.

**PITTSBURGH LECTRODRYER CORP.**

P. O. BOX 1008 . . . PITTSBURGH, PA.

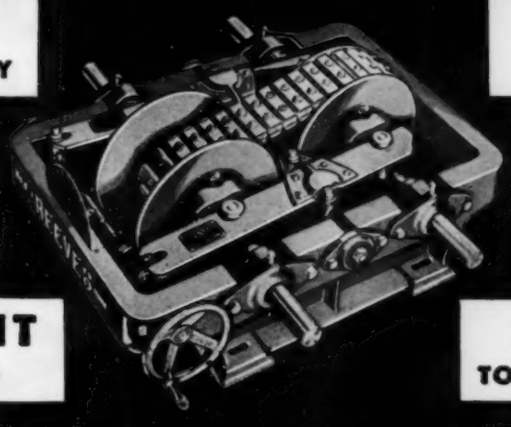
# Industry's PROVED Unit

## for providing Infinite Speed Adjustability to Any Driven Machine

**WIDE-RANGE**
OF SPEED RATIOS

**ACCURATE**
AT ALL SPEED SETTINGS

**INSTANT**
SPEED SELECTIVITY



**AVAILABLE**
IN MANY DESIGNS

**COMPACT**
IN DESIGN

**POSITIVE**
POWER DELIVERY

**CONVENIENT**
TO CHANGE SPEEDS

**SELECTIVE**
TO FRACTIONS OF R. P. M.

**ADOPTED**
BY 800 MACHINE BUILDERS

**PROVED**
IN 75,000 INSTALLATIONS

● VARIABLE speed requirements today *demand* variable speed drives of *many different* sizes, designs, types, controls—and a wide range of speed ratios.

REEVES engineers discovered years ago that one standard unit *cannot* serve all needs. Thus REEVES offers a *complete* line of variable speed transmissions—a *correct* unit for every requirement—for power applications from fractional to 125 H. P.; and a full range of speed ratios from 2:1 to 16:1 inclusive.

*Vertical Enclosed Design with "Centralized" Lubrication*

In the REEVES line you find compact horizontal and vertical models in open or enclosed designs (with or without unit motor mounting); also internal operating parts for *incorporating into* the machine regulated.

*Originators* of the Variable Speed Transmission, REEVES engineers have devoted years of practical study to make the REEVES Transmission the highly perfected speed control unit it is today. Every feature, including the basic design and construction, has been *time-tested* in exacting industrial service.

The latest REEVES catalog, and the personal counsel of REEVES engineers on your specific machine applications, offer you the most complete and dependable guidance in applying *proved* variable speed control to your machines. *To fit your machine utility to today's needs, mail coupon now.*

# ★ REEVES ★

## Variable Speed TRANSMISSION

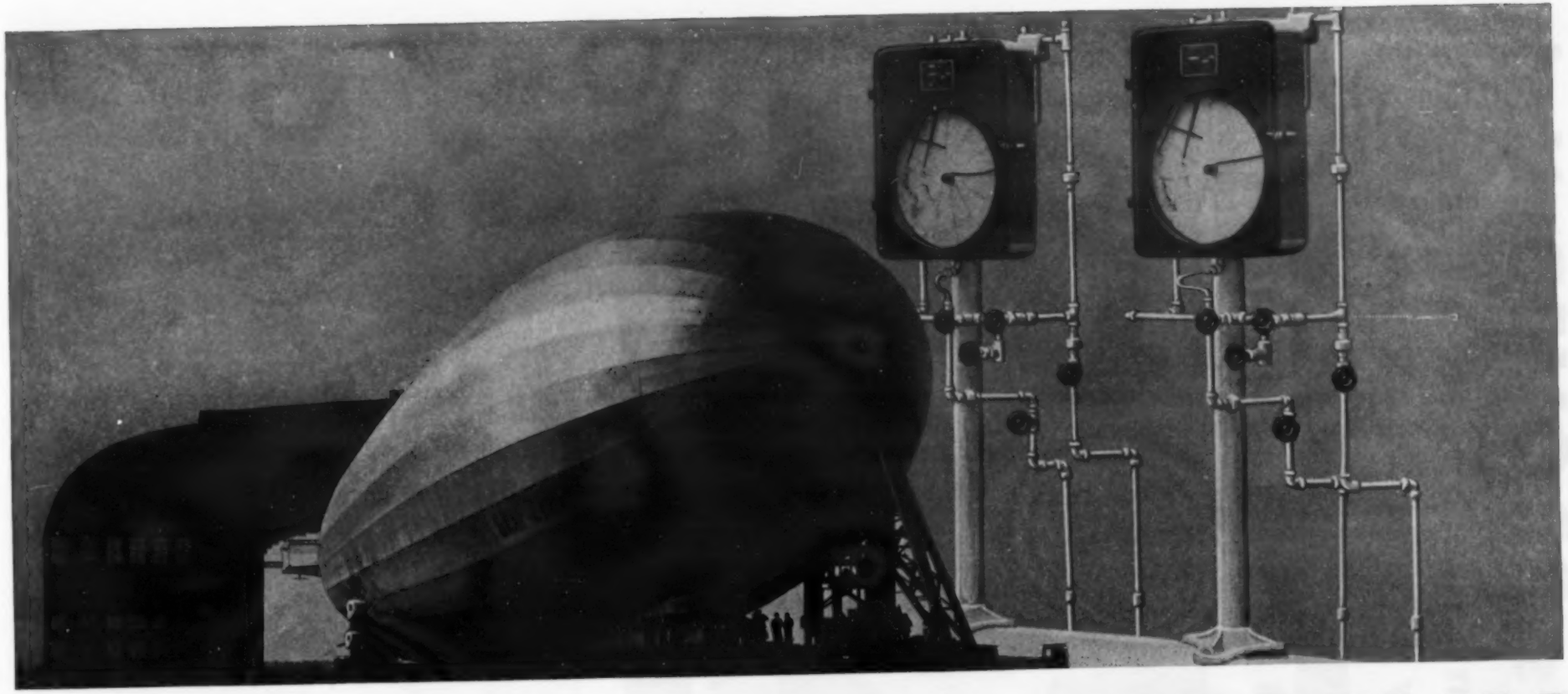
**REEVES PULLEY COMPANY, COLUMBUS, INDIANA**

Send information on applying variable speed to production machines, as contained in your latest Catalog C-99. **11-33**

Name.....

Company.....

Address.....



# HOW THE GRAF ZEPPELIN IS REFUELED • • •

**American Meter Company orifice meters have been utilized in refueling not only at Akron but at Lakehurst, Los Angeles, Tokio and Pernambuco, Brazil, to attain exacting degree of accuracy required.**

*Burning gas instead of gasoline in her motors, the Graf Zeppelin was refueled with*

in past refuelings of the giant ship in Tokio, Los Angeles and Lakehurst.

*Burning gas instead of gasoline in her motors, the Graf Zeppelin was refueled with 750,000 cubic feet of fuel gas before her recent trip homeward. Sixteen hours were required for the operation. The fuel gas is approximately 65 per cent Pyrofax and 35 per cent hydrogen.*

To obtain the high degree of accuracy required in the measurement and mixing of these two gases, two American Meter Company orifice meters are utilized.

This setup at Akron for measuring the fuel gases is the same as that employed in past refuelings of the giant ship in Tokio, Los Angeles and Lakehurst. A similar installation is used at the permanent base in Pernambuco, Brazil.

Choice of American Meter Company instruments in all cases is evidence of international recognition of their accuracy . . . a degree of accuracy established in the displacement measurement of the smallest laboratory pilot light's flow and maintained throughout the entire range of applications. Write for Engineering Bulletin EG2 for full data on the operation and many industrial applications of these instruments.

# AMERICAN METER COMPANY

INCORPORATED

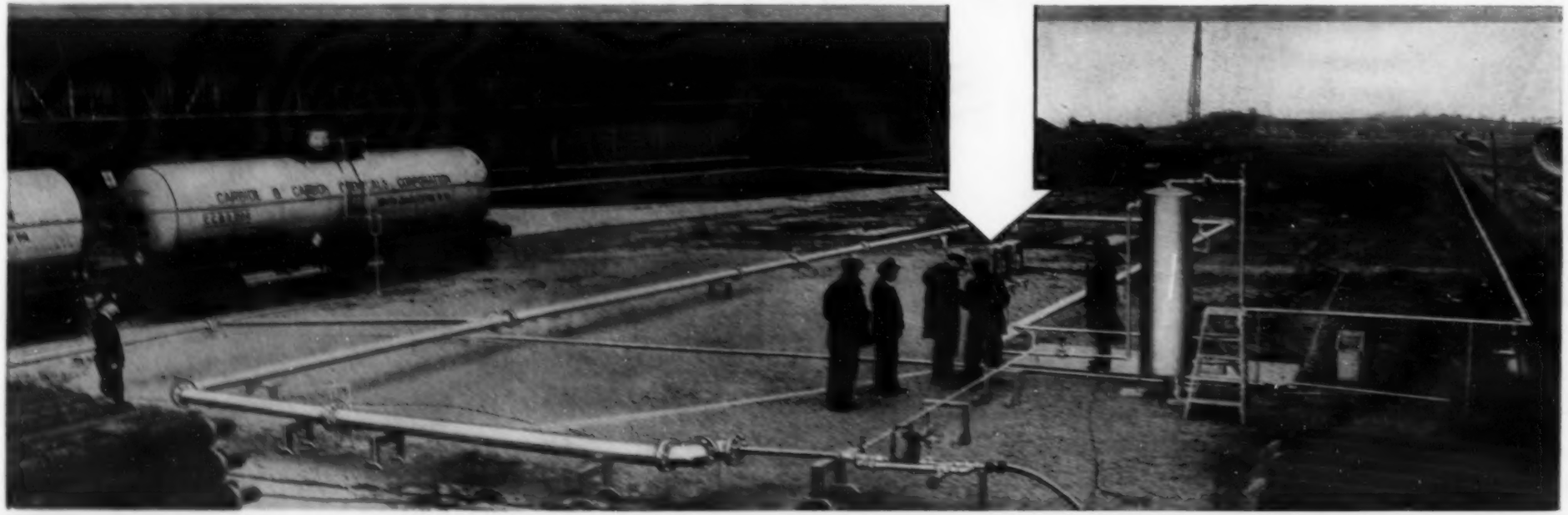
*Measurement and control of Gas, Oil, Steam, Air and Liquids*

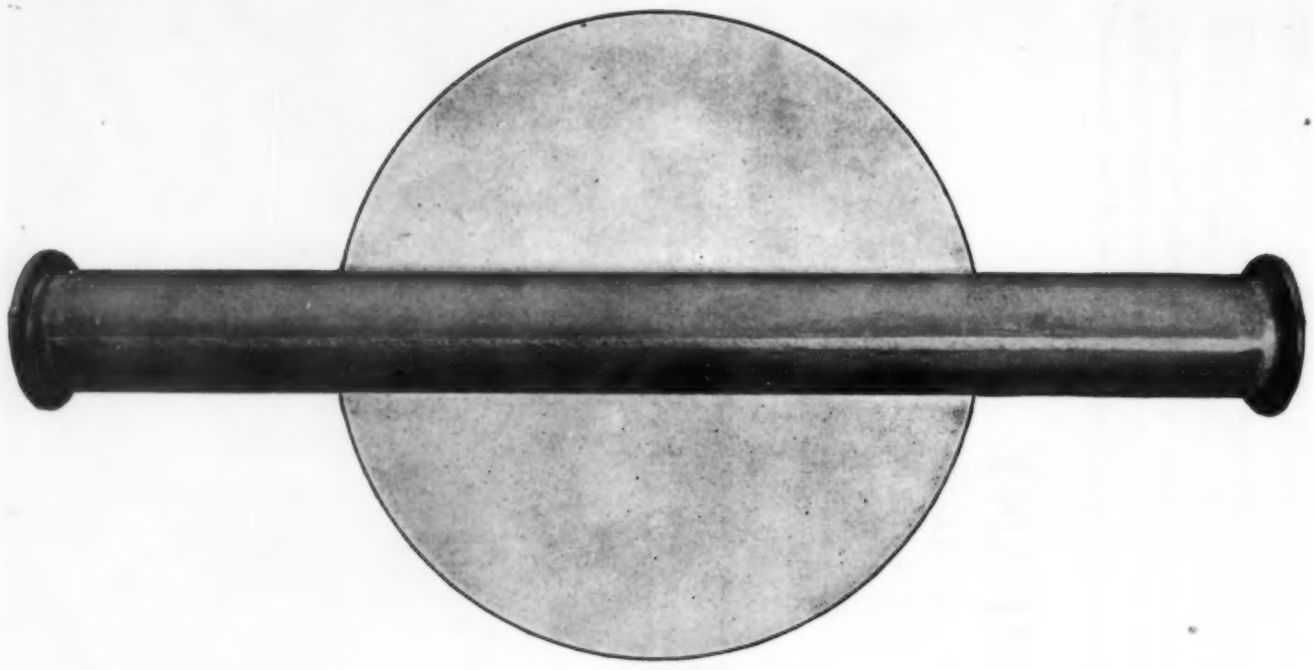
*ESTABLISHED 1836*

METRIC METAL WORKS *ERIE, PENNSYLVANIA*

Albany Baltimore Birmingham Boston Chicago Denver Erie Kansas City
Los Angeles Philadelphia Pittsburgh New York San Francisco
WESTCOTT & GREIS, INC., Dallas, Tulsa CANADIAN METER CO., LTD., Hamilton, Ontario

The Pyrofax gas is introduced into one end of the piping layout and hydrogen into the other end. These gases are mixed at a common outlet, and then flow through a tunnel into the air dock. Liquefied Pyrofax from the tank car is passed through a steam vaporizer, the steam being provided from the railroad locomotive shown on the siding. The hydrogen is brought in through a manifold connection and thence through a main control valve. To maintain the temperature of the two gases constant, and thereby eliminate the necessity for making corrections for flowing temperature, the hot Pyrofax gas from the vaporizer is cooled by refrigeration and the hydrogen is heated. Pyrofax gas supplied and refueling operations were supervised by Union Carbide & Carbon Corporation. Photo by courtesy of Goodyear Zeppelin Corporation.





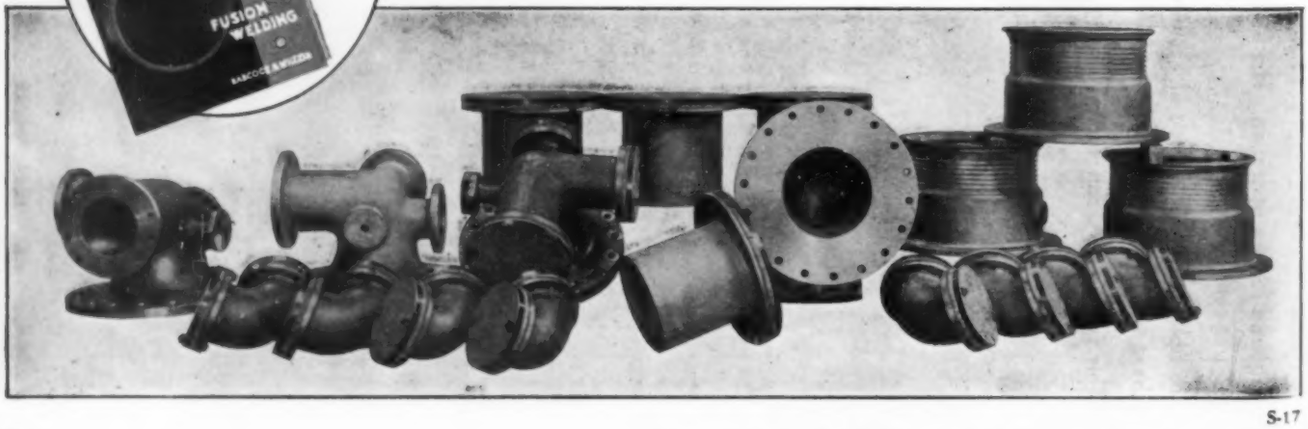
# Alloy Pipe and Fittings

Babcock & Wilcox Pipe and Fittings, fabricated or cast from corrosion and heat-resisting alloy steels, are now available in a wide range of sizes and arrangements that effectively meet the highly special requirements of the process industries.

The selection of the best material for each service is made by expert metallurgists who supervise the entire foundry procedure as well as the welding process used in fabrication.

For complete information, or for your copy of the second edition of *Fusion Welding*, address The Babcock & Wilcox Company, 85 Liberty Street, New York, N. Y.


## BABCOCK & WILCOX



S-17


POTENTIOMETER
STABILOG

# A New

# NOW Stabilog Control

REG. U.S. PAT. OFF.

## For Temperatures Up To 2800° F.

Here is an entirely new conception of control!

Extremely accurate measurement, not handicapped by distance or range, is given by the Potentiometer Pyrometer System. The control is Stabilog Control —air operated! There is nothing like it. It gives completely automatic control in any situation.

The Stabilog System of Control entirely eliminates manipulation of control equipment. It automatically corrects the process at a rate equal to the change in demand, and therefore, eliminates hunting or over-controlling.

Designed and built for process control, this instrument is housed in a fume-tight case with internally sealed connection box. The universal case may be mounted either flush or surface.

**THIS COMBINATION:**—The Stabilog System of Control (plus) the Potentiometer measuring system produces results not yet obtainable with any other device.

**THE POTENTIOMETER STABILOG:**—(plus) the recording Potentiometer Pyrometer results in a new standard of process control. The same thermocouples are used for both recording and controlling —but different mechanisms, unobstructed in their action, record and control the temperature accurately.

As many as six controller records can be made on one Recorder — with *one recorder mechanism and one chart.*

Separate thermocouples may be used for recording and controlling and are often very desirable.

FOXBORO
REG. U. S. PAT. OFF.
THE COMPASS OF INDUSTRY

# *Standard in Process Control!*

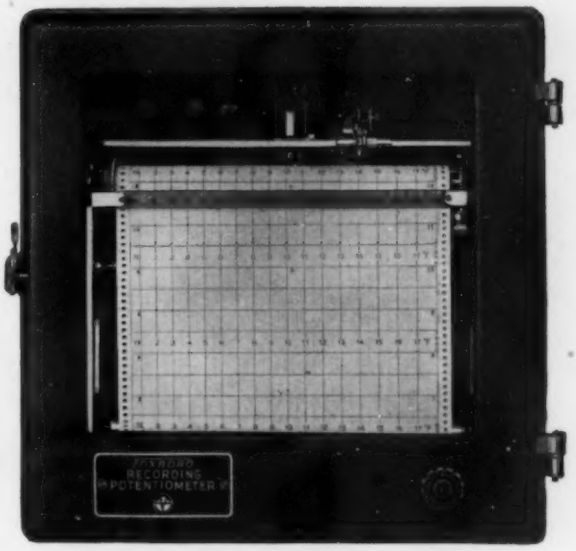
**The running mate of the Potentiometer Stabilog is this new Multiple Recording Potentiometer Pyrometer. It also is housed in a fume-tight universal case. Accuracy and durability are its outstanding charactistics.**

## Accuracy

***The slide-wire contact of the potentiometer system is mounted integrally with the recording mechanism.*** **This is not only the simplest mechanical design, but also the most accurate. There is absolutely no lost motion between the measuring device and the record.**

## Durability

**The balancing mechanism is entirely new and unique in design. It moves the print wheel rapidly from one end of the scale to the other without requiring fast movement of the mechanism. This means minimum wear and maximum trouble-free life. It also makes possible a very open chart scale and rapid frequency of records.**




POTENTIOMETER RECORDING PYROMETER

***Maximum legibility, so necessary to any industrial instrument, is assured by the open scale of the twelve inch chart. The different records, identified by distinct colors, are in plain sight as soon as they are made.***

## THE FOXBORO COMPANY

FOXBORO, MASS., U. S. A.

**BRANCH OFFICES IN PRINCIPAL CITIES**

*Complete Process Control*

***The symbol at the right is emblematic of the unique Foxboro Potentiometer balancing mechanism. It is the seal of rapid, accurate temperature recording.***

**SEND FOR BULLETIN 190**

It gives detailed information about the Foxboro Potentiometer Recording Pyrometer. Use this coupon for convenience.

**The Foxboro Company**
**Foxboro, Mass.**

Gentlemen:
Please send me Bulletin 190, "The Foxboro Potentiometer Recording Pyrometer."

Name .....

Address .....

State .....

# Does your Equipment Require SPECIAL METALS?

THE wide range of industries for which we have built processing equipment has built up a fund of experience in the new materials of construction.

This is available to you. Where you face new problems, we have a factory-scale laboratory to demonstrate performance and select those materials which will provide the best results.

Add to this the mechanical and chemical experience of 38 years in serving a wide variety of process industries, and we believe there is justification for visiting our plant or consulting us.

Stainless Steel Vacuum Rotary Dryer, also built in aluminum and other special metals, as required.

Drum-Dryer — with rubber-lined feed system to prevent electrolytic action. Seven units of this type (two of which are 5' x 17') are used for drying decolorizing carbon. They eliminate filtering prior to drying, and milling after drying.

**STOKES**
**Process Equipment**

Vacuum Rotary Dryers
Atmospheric Drum Dryers
Vacuum Shelf Dryers
Tablet Compressing Machines
Vacuum Impregnating Apparatus
Solvent Recovery Apparatus
Fractionating Columns
High Vacuum Pumps
Vacuum Stills
Crystallizers
Extractors
Evaporators
Mixers
Vacuum Fumigators
Water Stills
Autoclaves
Condensers
Deodorizers

*Special Process Equipment*

Special monel-metal autoclave for experimental work.

Electrically-heated all-nickel vacuum extractor.

SEND FOR CATALOG 31-A

**F.J.STOKES MACHINE COMPANY**

*Chemical Engineers and Equipment Manufacturers Since 1895*

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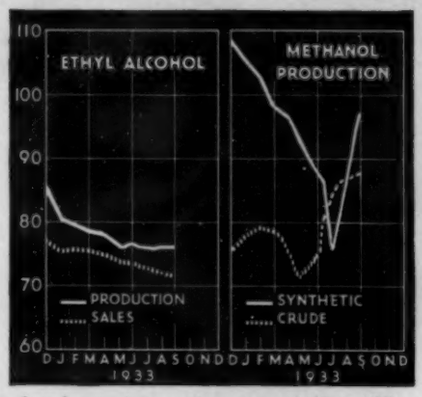
# SOLVENT NEWS

Reg. U. S. Pat. Off.

DECEMBER ★ A Monthly Series of Articles for Chemists and Executives of the Solvent-Consuming Industries ★ 1933




*(moving twelve-month averages, 1931 = 100)*

**CURRENT PRODUCTION**

| | | 1933 | 1932 |
|---|---|---|---|
| **ETHYL ALCOHOL** | | | |
| **Pure** | Jan.-Sept. | 90,305 | 103,010 |
| 1000 proof | Sept. . | 13,968 | 13,355 |
| gallons | Aug. . | 12,482 | 12,365 |
| **Sales** | Jan.-Sept. | 80,454 | 88,305 |
| 1000 proof | Sept. . | 13,268 | 12,548 |
| gallons | Aug. . | 10,232 | 14,392 |
| **METHANOL** | | | |
| **Crude** | Jan.-Sept. | 2,092 | 1,699 |
| 1000 | Sept. . | 243 | 98 |
| gallons | Aug. . | 262 | 99 |
| **Synthetic** | Jan.-Sept. | 5,089 | 5,887 |
| 1000 | Sept. . | 1,461 | 698 |
| gallons | Aug. . | 860 | 793 |

## CONSUMING INDUSTRIES TAKE LARGE DELIVERIES OF ALCOHOL

Different consuming industries have drawn heavily upon stocks of denatured alcohol in the last month. Anti-freeze requirements have taken seasonal amounts into consumption and demand from the rayon, lacquer, and other industries has held up well. Trading in forward positions was restricted because uncertainty about production costs made it difficult to establish an equitable trading basis. Recent developments, however, make it probable that industrial alcohol made from blackstrap will not be greatly affected.

As the anti-freeze trade offers a large outlet for denatured alcohol, weather conditions will be a market factor.

## NEW LINE OF THERMOPLASTIC CEMENTS INTRODUCED

New thermoplastic cements recently introduced are of interest to a wide range of industries because of their usefulness for laminating or cementing many different types of materials. Fragile fabrics may be permanently joined to tougher backings for shoes, handbags; wood shingles may have an insulating lining of metal foil; Cellophane may be sealed irretrievably to metal foil liners; paper, wood, glass, cork, metal, foil, linoleum, fabric, veneer, may be affixed permanently to each other.

The solid ingredients of these products are composed of nitrocellulose or cellulose acetate plasticizers and synthetic resin of the modified polybasic-acid, polyhydric-alcohol type which are dissolved in suitable solvents. These cements are waterproof and very flexible; also they are resistant to the action of oils and grease, and are not affected by mild acid and alkaline solutions. They do not become brittle on ageing.

The cementing operation is accomplished by a simple application of heat. Surfaces to be joined are coated with the cement by means of brush, spraygun or coating machine.

## CHIEF CHARACTERISTICS OF AVAILABLE AND "IDEAL" CELLULOSE ACETATE PLASTICIZERS

### *Dimethyl and Diethyl Phthalates Gain Wide Acceptance Among Plastic Manufacturers*

In the fabrication of cellulose acetate products, plasticizers are employed primarily to impart flexibility, although they may be expected to lower the melting point, decrease shrinkage, give flowing properties, reduce hygroscopicity, etc.

The "ideal" plasticizer should confer flexibility at both high and low temperatures, and possess the power of dispersing cellulose acetate. It should also have the features of high retentivity, compatibility with all raw materials, low vapor pressure, stability to light and heat, immiscibility with water, low inflammability, high dielectric strength and favorable cost. Color, taste, odor and toxicity should be absent.

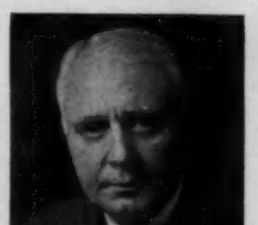
Needless to say, the ideal plasticizer has not as yet been developed and there are but few materials which do more than approach accord with the complete requirements cited above. Fortunately, however, fabricators have found that not all these ideal characteristics are needed at one time—and that, depending on the type of finished product desired, single selections or combinations may be chosen which will give satisfactory results for the work at hand. Usually it is the case that combinations give better results than any one plasticizer alone.

Dimethyl and diethyl phthalates are probably the most popular and widely used of the cellulose acetate plasticizers, possessing as they do, the major necessary qualifications. This is particularly true from a cost standpoint, and because of the moderate price, plastic manufacturers find it to their advantage to use as large a proportion of the phthalate plasticizers as is possible. A considerable tonnage of these methyl and ethyl derivatives is used either alone or in combination with other plasticizers in the manufacture of sheeting, film, transparent paper, moulding powder and insulating lacquers. For laminating glass where clarity, stability to light and heat, and flexibility at low temperatures are essential, dimethyl

*(Continued on next page)*

## TRIGG HEADS NATIONAL PAINT, VARNISH & LACQUER ASSOCIATION

Congratulations and good wishes are extended to Mr. Ernest T. Trigg on his election as President of the National Paint, Varnish and Lacquer Association, and to the association itself for the high type of leadership it has secured.



**Ernest T. Trigg**

Realizing the necessity for united action, members of the American Paint & Varnish Manufacturers Association and the National Paint, Oil and Varnish Association voted at their annual conventions, held in Chicago the latter part of October, to amalgamate these organizations into a new association, to be known as the National Paint, Varnish and Lacquer Association.

Mr. Trigg, who gives up his present position as president and general manager of John Lucas & Co., Inc., to assume his new office, has long been a dominant figure in the industry. He has also been active in paint trade association activities and during the past five months, as chairman of the General Code Committee of the Paint, Varnish and Lacquer Manufacturing Industry, has worked unceasingly in the preparation of the Code—following it through official channels until it was signed by the President October 31.

**FILLING ETHYLENE CYLINDERS: Filling room in the Ethylene department of U. S. I. Ethylene is a hydrocarbon gas derived directly from ethyl alcohol. It is compressed to about 1700 pounds per square inch and loaded into steel cylinders as illustrated.**

**The major uses of Ethylene are for anesthesia, for fruit and vegetable conditioning and for cutting and welding operations. As a safe and effective anesthetic, Ethylene has made tremendous strides within the past few years.**

*Published Monthly by the U. S. Industrial Chemical Co., Inc.*

## CHIEF CHARACTERISTICS OF AVAILABLE AND "IDEAL" CELLULOSE ACETATE PLASTICIZERS

(*Continued from preceding page*)

phthalate is found most adaptable.

Other cellulose acetate plasticizers which are commonly used with the dimethyl and diethyl phthalates are dibutyl phthalate, triphenyl- and tricresyl-phosphates, triacetin, diamyl and dibutyl tartrates, benzyl alcohol and some of the sulphonamides and sulphonanilids offered under the trade name "Santicizer."

The literature contains many references to other products which have been suggested for this purpose should the reader care to pursue the subject further.

## NEW BASE FOR PHENOLIC RESIN MOULDING AND LAMINATING

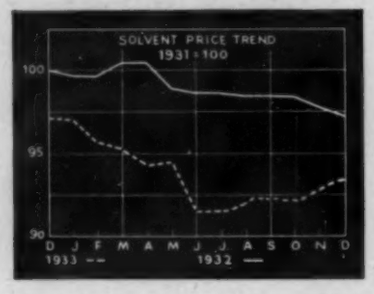
This new material consists of composite sheets having a sheet steel backing and a resin veneer surface. The surface coating is applied by means of an intermediate coating of fibrous material attached directly to the steel sheeting by means of a low-melting alloy. The phenolic resin is then attached to the prepared side by heat and pressure.

The veneer surfaces thus obtained show superior strength and adhesion, and are said to permit a great variety of surface effects and colors. It is stated that other resins may be used, and that the material is not restricted to sheeting but applicable to other shapes as well.

**A process for the manufacture of rayons,** as hardy as fabrics from silk, cotton or wool, has been reported. The claim is made that the rayon processed by this new method may be hot ironed, or soaped and washed in either hot or cold water and then hot ironed, because the process makes all rayon fabrics heat-proof.

* * *

**Lump formation** in swelling or dissolving finely divided substances such as gutta-percha, balata, rubber, soap powders, gums, resins, etc. may be prevented by retarding the rate of swelling or solution, according to a British Patent. The process consists of aggregating the substance into a powder of porous particles of larger grain size than the original after slightly moistening with a small proportion of liquid.




### SOLVENT PRICE TREND

While there were some fractional declines in sales prices for petroleum solvents and diluents in some sections of the country, the market for solvents in general was firm with a tendency toward higher levels. Alcohol, both pure and denatured was firmly held.

The index number for prices is 93.35 which compares favorably with a revised number of 93.33 for the preceding month.

## SIMPLE TEST FOR ADHESION OF PAINT TO METAL SURFACES

The following method for determining the adhesion of paint coats on metal surfaces is based on the conception that the adhesion of the primary coat is the all important factor.

The test itself is carried out by gluing wooden blocks upon the primary coat, cutting the paint around the block and then measuring the load required to tear off the block. In all cases a direct measure of the adhesion of the paint coat in grams per square centimeter can be obtained.

If the paint coat adheres too strongly, however, the glue itself will tear and in this case the only measurement possible is that the adhesion of the paint coat is greater than that of the glue.

### Production Trends in Major Solvent-Consuming Industries

| | *October* | *September* | *January-October* | |
|---|---|---|---|---|
| | | | *1933* | *1932* |
| **CHEMICALS:** index of production (1931=100) | 102.6 | 100.5 | 92.9 | 88.5 |
| **LEATHER:** index of production (1931=100) | .... | 103.4 | 107.7* | 93.5* |
| **LEATHER, ARTIFICIAL:** pyroxylin spread, 1000 lb. | 2,697 | 2,761 | 31,734 | 21,246 |
| **PAINT, VARNISH, and LACQUER:** sales ($1000) | .... | 19,098 | 171,426* | 165,754* |
| **TEXTILE (Cotton) FINISHING:** 1000 yd | 71,669 | 57,471 | 835,614 | 673,355 |

**January-September*

## TECHNICAL DEVELOPMENTS

**Greater durability is imparted to varnishes** containing China wood oil and linseed oil by the introduction of antioxidants to prevent the oxidation and drying of the linseed oil, without affecting the drying of the China wood oil. Such a varnish is said to dry in a few hours, yielding a hard, tack-free, glossy, water- and acid-resistant film. Resorcinol is a suitable antioxidant according to this German patent.

* * *

**Weatherproof properties** may be given transparent foils such as cellophane by coating with transparent lacquers. The weather proofing may be tested by loss of moisture from a moist material within a tightly enclosed membrane made of the foil.

* * *

**A waterproofing treatment for fabrics** without affecting their appearance, is said to permit men's suits, women's dresses, hats, silk hose, flags, etc. to be immersed in water without getting wet. It is expected to be useful for protecting the wings of airplanes against ice formation.

* * *

**Damp surfaces** may be made ready for painting by priming them with a mixture of alcohol and solvent naphtha containing a small amount of heavy oil or asphalt, according to reports of another German patent.

* * *

**A new oil-resistant resin** with good dielectric properties is offered for use in insulating varnishes, lacquers, emulsion paints and thermoplastics, especially of the phenol-formaldehyde type. It is hard, black, tough and non-tacky; insoluble in drying oils and most varnish thinners, but soluble in lacquer solvents.

* * *

**A general purpose interior finish,** available in several colors, claimed to be both acid and alkali-proof, and impervious to water, grease, oil or chemical fumes is now on the market. It may be used without primer on walls, floors or machines, requiring but one hour for drying.

* * *

**A penetrating varnish,** developed by a flooring manufacturer, seals the wood against absorption or moisture although it contains no waxes or non-drying oils. It is said to be equally suitable for an undercoat or finish, and does not flake, scrape off, scratch or mar easily.

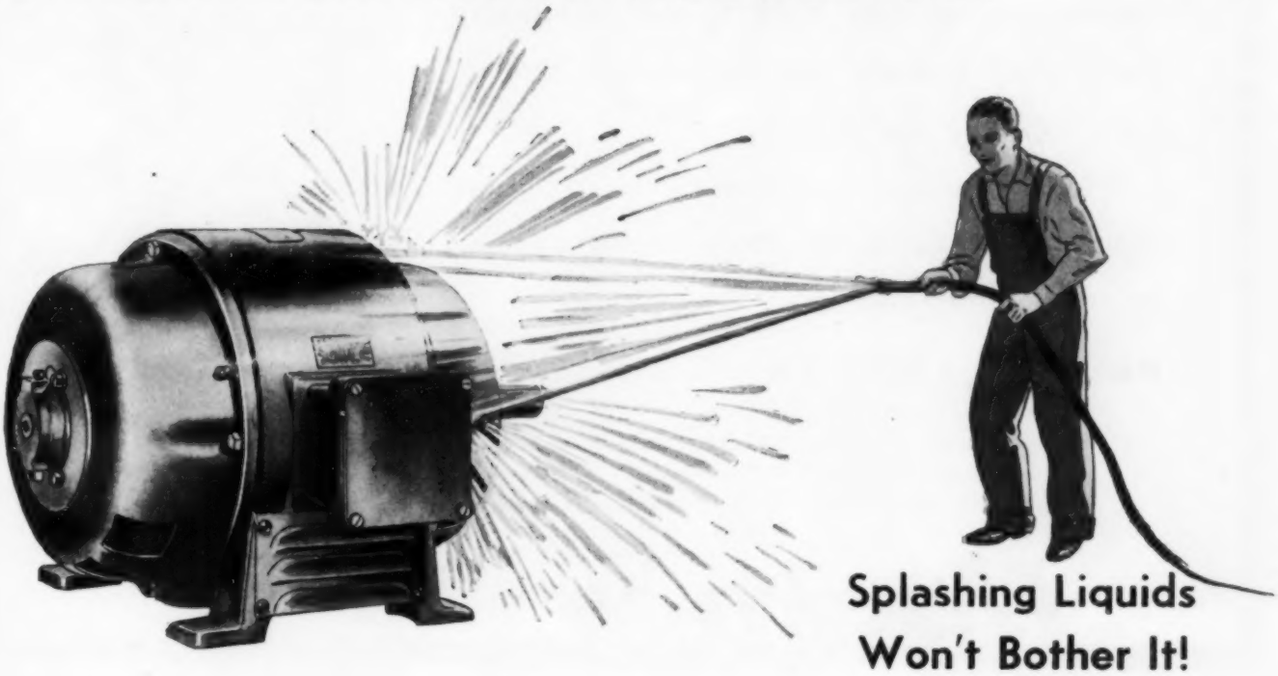
* * *

**An all-purpose filling machine** handles paint, varnish, shellac, greases, food products, soap, etc. Features stressed by the maker are accuracy, quick change-over and cleaning accessibility. Speeds up to 40 units per minute are possible, with automatic or foot-pedal control.

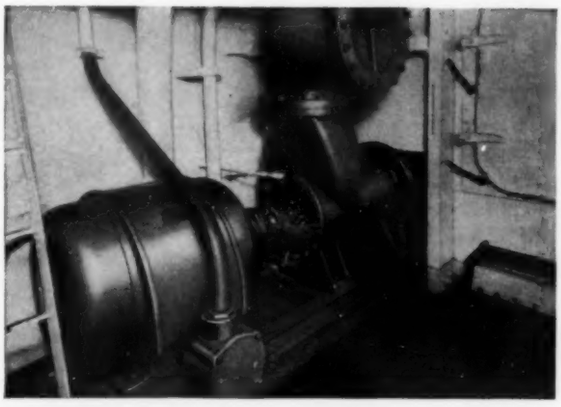
* * *

**A new inorganic resin,** stated to be a clear glass-like material which is soluble in water but insoluble in organic solvents, oils, etc., is being produced commercially. It is said water solutions of this product resemble sodium silicate solutions in giving dry, glossy, flexible films but differ in being neutral and chemically unaffected by acids or alkalies.

# *You can turn a hose on this motor...*



**Splashing Liquids Won't Bother It!**



*50-hp. splash-proof motor driving a pump*

INSTALL G-E splash-proof motors in those applications where your equipment is subjected to splashing or dripping liquids. You can even wash your machines with a hose without injury to the motors.

Liquids are prevented from entering G-E splash-proof motors—

1. **At the ventilating openings, by special baffles extending to the center line of the motor**
2. **At the leads, by a specially designed conduit box**
3. **At the shaft, by cartridge-type bearing housings**

G-E splash-proof motors are available in ratings ranging from 1/2 to 75 horsepower, at all standard speeds and voltages. We shall be glad to supply further information—simply use the coupon below.

200-735

**GENERAL ELECTRIC**

GENERAL ELECTRIC CO.,
Dept. 6-201, Schenectady, N. Y.

Please send me a copy of your publication on G-E splash-proof motors (GEA-1619).

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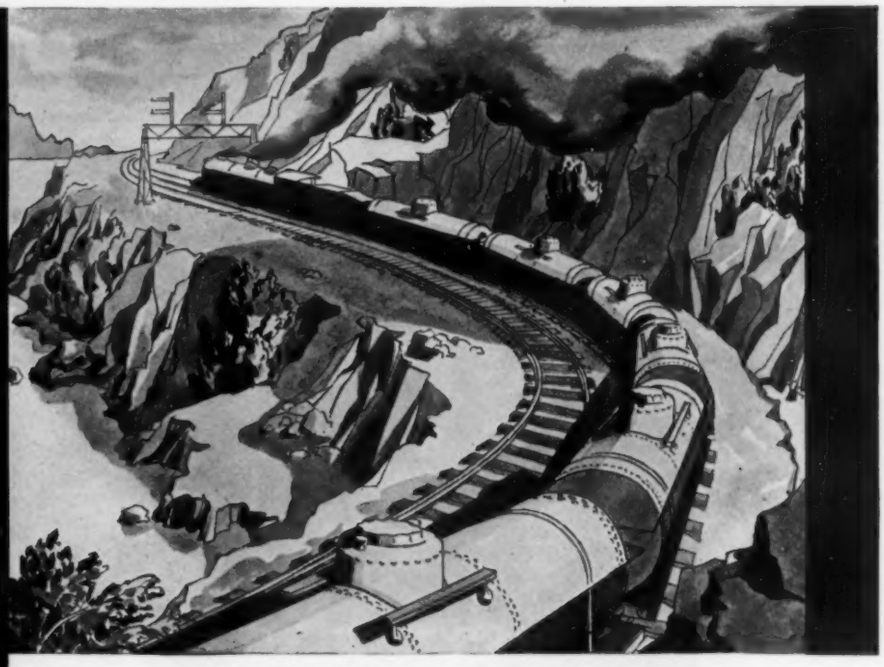

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Aluminum Chloride Crystals
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Ammonium Nitrate
Ammonium Sulphate 99.9%
Aqua Ammonia
Aqua Fortis
Arsenic Acid
Barium Carbonate
Barium Chloride
Barium Sulphate—Blanc Fixe
Battery Acid
Battery Coppers
Battery Zinc
Bi-Sulphate of Soda
Bi-Sulphite of Soda Solution
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C. P. Hydrochloric Acid
C. P. Nitric Acid
C. P. Sulphuric Acid
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Cadmium
Cadmium Anodes
Cadmium Hydrate
Cadmium Sulphide
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Duclean—Iron drum cleaner
Electrolyte
Formic Acid
G. B. S. Soda
Glauber's Salt
Glauber's Salt Anhydrous
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Lactic Acid
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Muriatic Acid
Nitric Acid Commercial
Nitric Acid Fuming
Nogas
Oleum
Phosphate of Soda
Phosphate of Soda—Anhydrous
Phosphate of Soda—Mono
Potassium Silicate Glass
Potassium Silicate Solution
Sal Ammoniac
Salt Cake
Sherardizing Zinc
Silicate of Soda Granulated
Silicate of Soda G.4.S.
Silicate of Soda Lump
Silicate of Soda Meta
Silicate of Soda Pulverized
Silicate of Soda "R-B"
Silicate of Soda Solid Glass
Silicate of Soda Solution
Snowflake Soldering Salts
Sodium Silico Fluoride
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Sulphide of Soda Concentrated
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Sulphide of Soda Flake
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Sulphuric Acid
Super-Phosphate
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Zinc Anodes
Zinc Chloride Fused
Zinc Chloride Granulated
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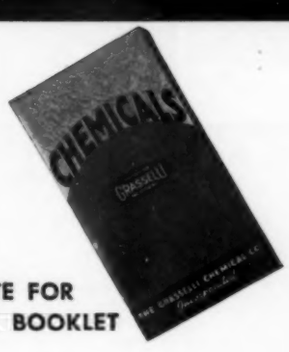


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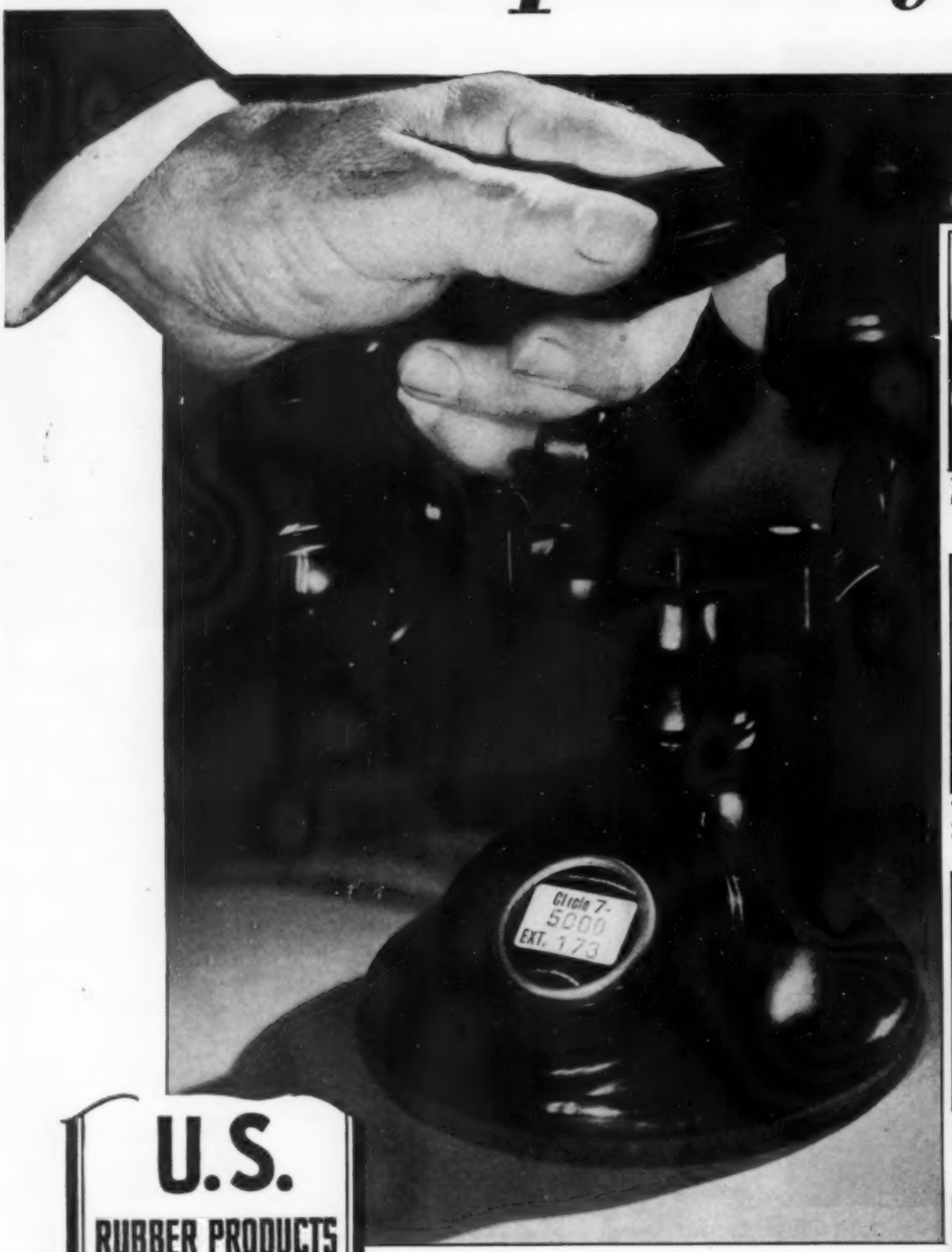


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**The "U. S." line of belting includes: Conveyor, Elevator, Transmission, Endless, Acid, Emery Polishing, etc.**

**Hose, from large diameter dredging sleeves to the smallest tubing.**

**From the famous "Rainbow" Sheet Packing to high and low pressure Rod and Valve Stem Packings.**

# SPECIFICATIONS

**Specify duck-weight, adhesion, tensile, elongation, gravity, burst–and you merely establish standards below which a product must not fall.**

**But those *extra* values above test or specification requirements, that are the fruit of long experience, supreme skill and a complete knowledge of service conditions and demands, are beyond the scope of the most rigid specifications.**

**Your only assurance of getting these plus values is in the selection of a manufacturer.**

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## —United States Rubber Company—

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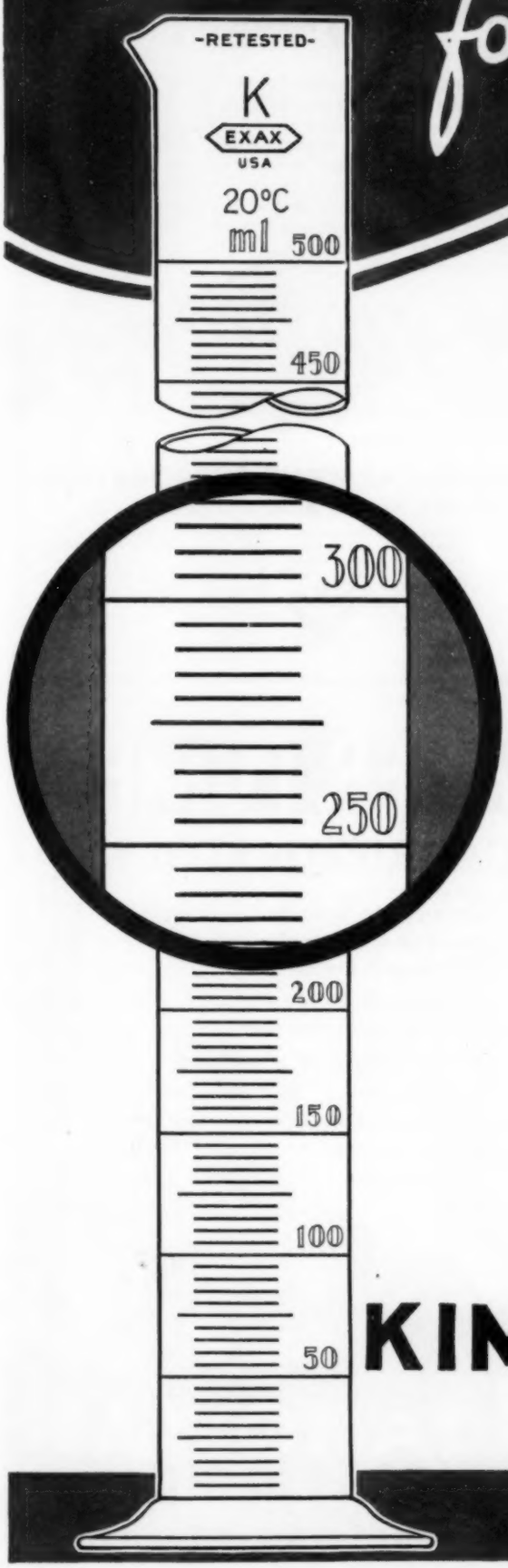
# BLUE LINE EXAX CYLINDERS *for Assurance*




THE graduated cylinder is one of the mainstays in scientific laboratory work. Its calibration must be accurate if results are to be relied upon. Kimble Blue Line Exax Cylinders—blown in paste moulds to produce a highly polished surface—permit reading of all liquid levels without error or distortion.

**IMPORTANT FEATURES**

1. Each cylinder is calibrated at 20°C at enough points to assure accuracy of intermediate divisions.
2. Lining and numbering are done by automatic machines.
3. All lines are deeply acid-etched and filled with a durable blue glass enamel, actually fused in.
4. An entirely new type of calibration lining for accurate and rapid reading. Short lines for intermediate divisions with encircling lines at the main graduation points.
5. All Kimble Blue Line Exax Cylinders are retested, and are retempered (strain-free) to eliminate weak spots.
6. The lips are finished so that liquid can be poured slowly without running down the sides.
7. All bottoms are ground so as to rest perfectly level.

*The following tolerances are allowed:*

| | | | |
|---|---|---|---|
| 5 *ml.* | ±0.10 *ml.* | 250 *ml.* | ±1.4 *ml.* |
| 10 *ml.* | 0.10 *ml.* | 500 *ml.* | 2.6 *ml.* |
| 25 *ml.* | 0.30 *ml.* | 1000 *ml.* | 5.0 *ml.* |
| 50 *ml.* | 0.40 *ml.* | 2000 *ml.* | 10.0 *ml.* |
| 100 *ml.* | 0.60 *ml.* | | |

*Stocked by leading Laboratory Supply Houses throughout the United States and Canada.*

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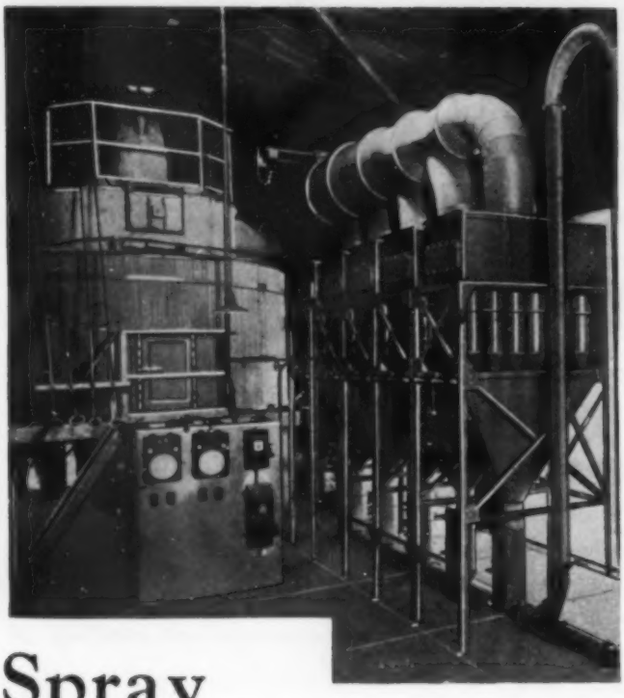

# Spray Drying or Dust Collecting

## in PROCESS INDUSTRIES

If you are interested in producing a better product without increasing production costs, or in producing the same product at a lower cost, investigate one or both of these processes.

### PEEBLES-WESTERN
### SPRAY DRYERS

Manufacturers of powdered products will find that installations of this process of spray drying will reduce fuel, labor and power costs to a minimum. The advantages obtained through the simplicity of operation and uniformity of products, when compared with milling operations involving leaching, filtering, drying, grinding, classification, etc., instantly prove its value. There is only one operation—material going into the Dryer as a solution and leaving as a powder of uniform particle size.

### MULTICLONE DUST COLLECTORS

●

The Multiclones illustrated above are collecting finished powder from a Peebles - Western Spray Dryer in an installation where immediate removal of product is of importance. The Multiclone Dust Collector is a more efficient centrifugal dust collector with lower power costs. No moving parts to wear out. Turbulence reduced to a minimum. Collected dust mechanically removed. Small floor space required. Unit construction facilitates installation and adding of additional capacity. Low maintenance and operating costs.

●

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# If It's a $CO_2$ Question ASK US

Naturally 40 years of specializing in Carbon Dioxide have developed research, manufacturing and testing facilities to the highest degree in the "Liquid" organization. Pure Red Diamond $CO_2$ is used in many laboratories and factories—could be used to advantage in others—could be put to new uses perhaps in your plant. Certainly it is a simple step to ask us as specialists, to study your problem and present our recommendations.

Liquid

Write for an interesting bulletin, "THE USES OF CARBON DIOXIDE"

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# TABER PUMPS

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DURABILITY RELIABILITY

Through the interchange of impellers Taber standard single suction Centrifugal Pumps serve also as custom-made pumps . . . and shipment is made from stock.

Whether you need a standard or a special pump . . . send your inquiry to Taber to know how well and how quickly you can be served. Write for comprehensive Bulletin No. G-631.

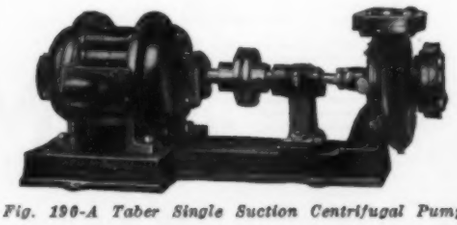


*Fig. 190-A Taber Single Suction Centrifugal Pump*

**TABER PUMP Co**

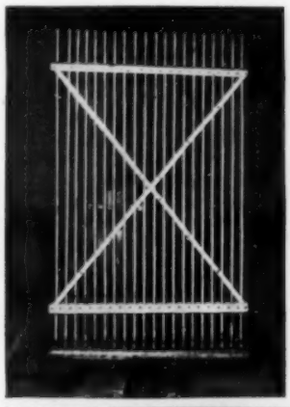
ESTABLISHED 1859

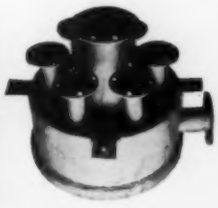
294 Elm St., Buffalo, N. Y.

# WELDED *Equipment of Nickel, Monel Metal and Nickel-Clad Steel* for SEVERE CHEMICAL SERVICE

## *built by Liberty Coppersmithing Company*

**Condensers** *Welded pure Nickel condenser shell equipped with pure nickel tube plates and tubes. Sea water is the cooling medium. A corrosive organic product is being condensed. Built by Liberty Coppersmithing Co. 1708 N. Howard St., Philadelphia, Pa.*



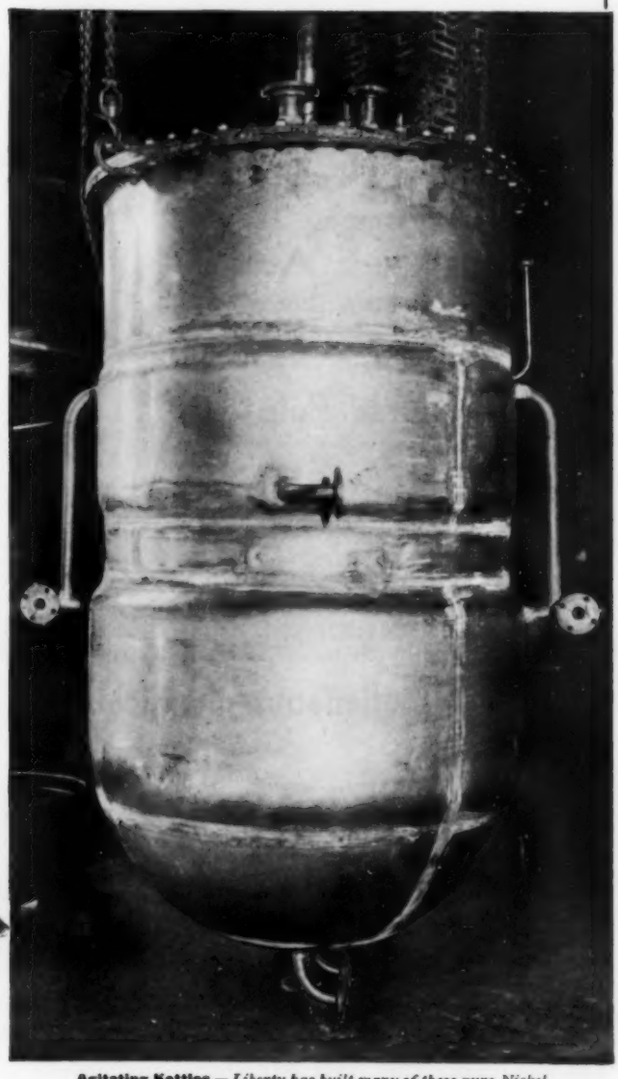


**Special Piping** (Above) *This Liberty job is a special distributor piping assembly built of pure Nickel for use with caustic soda. All joints are welded.*

**Heating Coils** (Left) *Welded pure Nickel manifold coil for resin melting box built by Liberty for a well-known manufacturer of organic chemical products.*

**Gravity Filters**—*Liberty handles Nickel-Clad Steel. These filter tanks with false bottoms are of welded construction.*

**Crystallizers** — *This welded Monel Metal crystallizing tank 32 in. deep, 48 in. wide and 16 ft. long—built by Liberty—is withstanding severe chemical plant service.*



**Agitating Kettles** — *Liberty has built many of these pure Nickel all-welded, steam-jacketed resin processing pressure kettles equipped with pure Nickel stirring device, flanged connections, etc.*

●Welded construction is often required for extremely severe service... and, fortunately for the chemical manufacturer, Nickel in its commercial forms is readily welded. That fact is also true of Monel Metal and Nickel-Clad Steel. Each of these can be welded readily and successfully under careful fabricating conditions.

Witness the equipment illustrated on this page, made by the Liberty Coppersmithing Company of Philadelphia. Liberty specializes in the design and manufacture of corrosion-resisting equipment for the process industries and where welded construction is called for... they produce it under regular shop routine. Years of service demonstrate the reliability of Liberty's welded or silver brazed equipment built of pure Nickel, Monel Metal or Nickel-Clad Steel, including:

**Agitating Kettles**
**Autoclaves**
**Coils and Condensers**
**Crystallizers**
**Distillation Equipment**
**Evaporators**
**Hoppers and Chutes**
**Special Machinery**
**Special Piping and Fittings**
**Tanks and Tank Linings**
**Vacuum Pans**

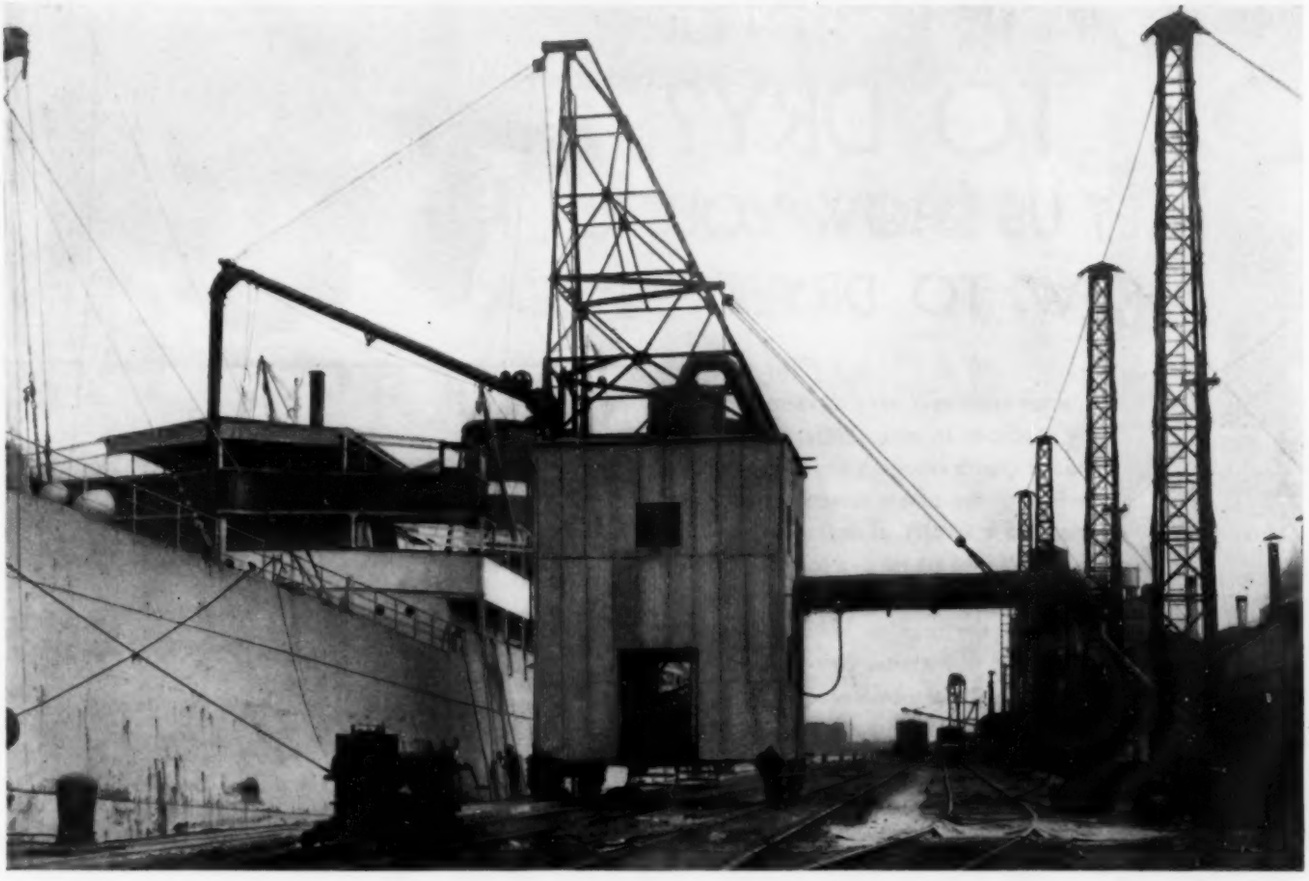
If you require equipment of welded construction for severely corrosive service, investigate the advantages of these metals:

**NICKEL** — **NICKEL-CLAD STEEL** — **MONEL METAL**

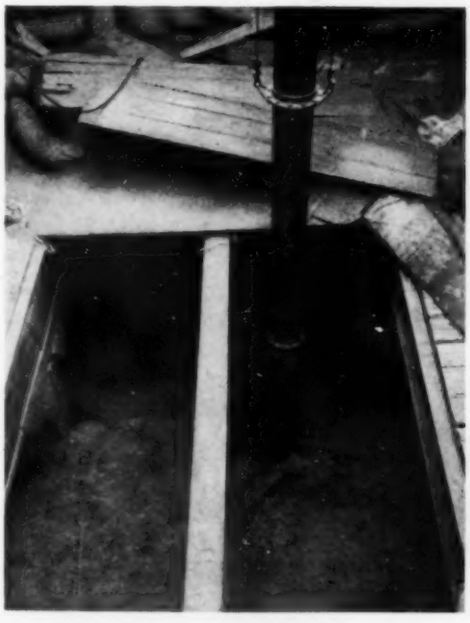
Send for a copy of the booklets, "*Nickel and Nickel Alloys in the Chemical Field Today*" and "*The Design and Construction of Heavy Equipment in Monel Metal and Pure Nickel*"

**THE INTERNATIONAL NICKEL COMPANY, INC.**
**67 Wall Street, New York, N. Y.**

# *Cut your unloading time*



This travelling Airveyor tower is unloading flaxseed at a rate in excess of 60 tons an hour. The seed is separated from the conveying air, discharged by an air-lock feeder to the belt conveyor, shown at the rear of the tower, and spouted to storage or direct to cars.



The marine leg terminates in a suction nozzle provided with four hose connections to recover seed from remote corners of the hold. Note the flow toward the nozzle. The bagged seed is used to prevent the load from shifting at sea.

## THIS AIRVEYOR IS UNLOADING FLAXSEED

**Similar travelling towers are unloading other fine, crushed and granular materials, including crushed coal and wheat. One or two men can readily operate the Airveyor. Operating costs are low, but the most important saving is in the time saved in unloading. The tower is easily moved from hatch to hatch to keep the ship in trim.**

**Airveyors are available in a wide range of capacities and types, for unloading cars, trucks and ships, and recovering bulk materials from storage. Write for complete information.**

**Fuller Company**
**CATASAUQUA, PENNA., U. S. A.**

**Chicago: 1118 Marquette Bldg.**

## FOR CUTTING COSTS IN PROCESS OPERATION


Round-Chart
MICROMAX
MODEL R
About ¼ Actual Size

# A DIAL LIKE A TOWN CLOCK

Other L&N Products For Cutting Costs in Chemical Operations

pH Indicators, Recorders and Controllers

Conductivity Indicators, Recorders and Controllers

Micromax Potentiometer Pyrometers

Precision and Semi-Precision Instruments for Plant and Laboratory

Combustion Controls

Pressure Controls

Gas Analysis Indicators and Recorders

Here's an indicating recorder that is built for temperature, pH, conductivity, smoke, $CO_2$, etc. It helps improve almost any process in the chemical industries. With it you can control by hand, or it can be built as an automatic 2-position or 3-position controller.

Because the big indicating dial of this Micromax machine looms through steam and vapor like a town clock, a man doesn't have to leave his work to read it. He looks across the room, instead of walking across.

This Round-Chart Micromax is a balance-method Recorder as distinguished from a spring-method or deflection instrument. It is by nature more dependable than a spring (or helix) recorder, just as a balance scale is more dependable than a spring scale. The Round-Chart Micromax is intended for those applications where reliability and low-upkeep costs are required, plus a giant scale. It is priced to make these advantages available at lower cost than ever before.

***Complete Details on Request***

T-322

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**4901 STENTON AVENUE PHILADELPHIA, PA.**

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RECORDERS AND CONTROLLERS FOR ALL INDUSTRY

# DEVINE

## engineering-designing-fabrication

## offer you NEW possibilities in equipment performance

Devine engineers know the relative values and possibilities of all the new metals such as solid stainless and stainless clad steels, and in every case suggest the material most suitable for the equipment.

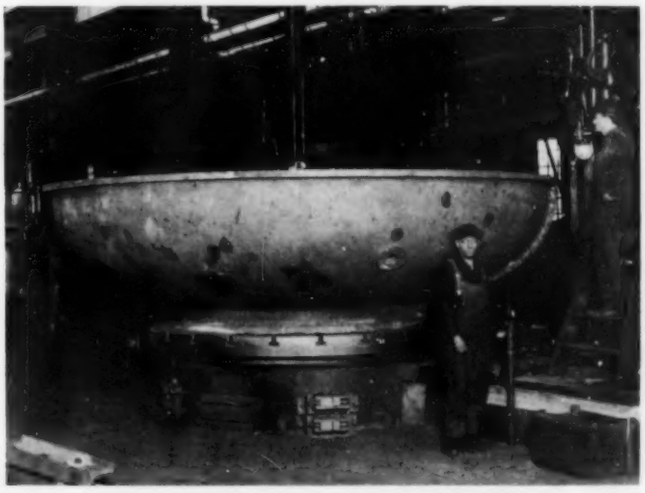
Illustration shows a section of a special nickel cast iron chemical kettle. Many other Devine results testify to our ability to successfully work in all modern metals.

Devine engineers are available for consultation at any time and will gladly cooperate with you in solving your equipment problems. The Devine Experimental Laboratory is a feature of our service. It is equipped with every type of process equipment so that tests can be made to assure dependable and economical results for you.

**OUR JOB is to correct your process equipment troubles and thereby reduce costs, increase quality and speed up production. To accomplish this we have over a period of years perfected an organization with extensive facilities and able personnel thoroughly experienced in the problems of the Chemical and Allied Industries.**

**Devine process equipment is designed and manufactured to fit your particular needs and to better your operations. Our engineers make a special study of the conditions surrounding your production and advance recommendations based on long experience and successful results.**

**Our extensive facilities make it possible to undertake and perfect drying, evaporating, impregnating, distilling, or special equipment of the most unusual types.**



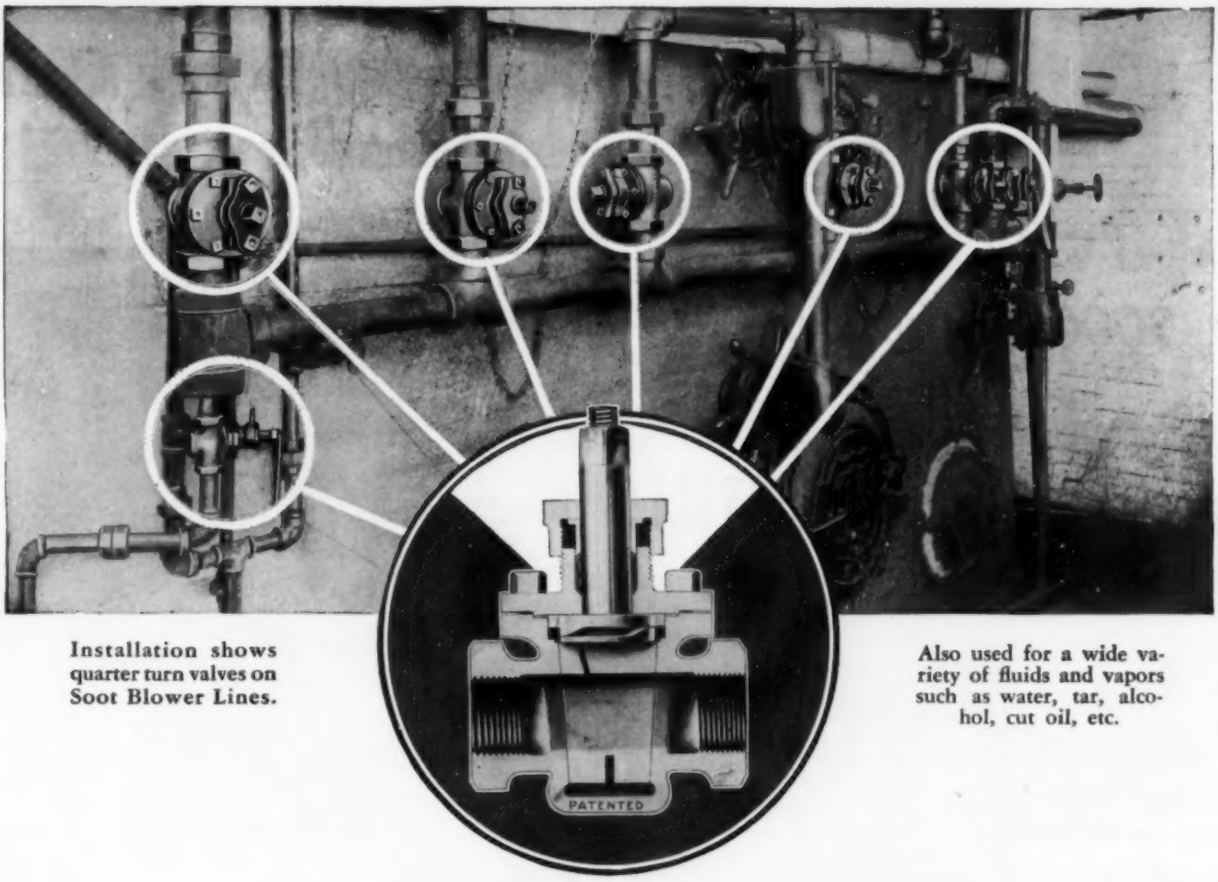
J. P. DEVINE MANUFACTURING CO., Inc.

*Division of Mt. Vernon Car Mfg. Co.*

MT. VERNON ILLINOIS

New York Office: 205 E. 42d Street
Chicago Office: 307 N. Michigan Avenue

# Devine PROCESS EQUIPMENT




Installation shows quarter turn valves on Soot Blower Lines.

Also used for a wide variety of fluids and vapors such as water, tar, alcohol, cut oil, etc.

## YEARS OF STEAM TIGHT SERVICE
*plus*
## SPLIT-SECOND VALVE CONTROL
*equals*
## HOMESTEAD QUARTER TURN VALVES

LIKE hundreds of others who have installed Homestead Quarter Turn Valves, you will be completely sold on the patented features of these remarkable valves the minute you examine their unique design and construction.

A single twist of the wrist fully opens or closes a Homestead Valve and in addition the special plug design provides a positive seating that defies the most insistent steam pressure.

It is the fastest operating valve made . . . opens and shuts with only a quarter turn of the valve stem . . . assures an unobstructed, straight through passage in the open position and a perfect seal that is air tight, steam tight and liquid tight in the closed position.

These valves with their carefully ground seating surfaces plus the positive seating action of the patented Homestead Cam assure long carefree service free from the injurious attacks of sand, grit and scale—a feature greatly appreciated by maintenance men as well as foresighted executives.

*Do you have the latest Homestead Valve Catalogue?*

Homestead Valve Manufacturing Company . . . Coraopolis, Penna.—*P. O. Box 208-C*

# HOMESTEAD VALVES

QUARTER TURN VALVES:
STRAIGHT WAY
THREE WAY
FOUR WAY
LUBRICATED TYPE
ROUND OPENING REFINERY

PROTECTED SEAT VALVES:
HYDRAULIC (B.&O. PAT.) OPERATING
REMOTE CONTROL
ROSS AIR SHUT-OFF VALVE
HOVALCO BLOW-OFF VALVE

# SEARCHLIGHT SECTION

## EMPLOYMENT : BUSINESS : OPPORTUNITIES : EQUIPMENT—USED or RESALE

UNDISPLAYED—RATE PER WORD:
*Positions Wanted*, 5 cents a word, minimum $1.00 an insertion, payable in advance. *(See ¶ on Box Numbers.)*
*Positions Vacant* and all other classifications 10 cents a word, minimum charge $2.00.
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INFORMATION:
*Box Numbers* in care of our New York, Chicago and San Francisco offices count 10 words additional in undisplayed ads.
*Discount* of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

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1 inch.....$6.00
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COPY FOR NEW ADVERTISEMENTS RECEIVED UNTIL 10 A. M. THE 9TH OF THE MONTH FOR THE ISSUE OUT THE 15TH OF THE MONTH C.M.

### EMPLOYMENT SERVICE

SALARIED POSITIONS, $2,500 to $25,000. This thoroughly organized advertising service of 24 years' recognized standing and reputation carries on preliminary negotiations for positions of the caliber indicated, through a procedure individualized to each client's personal requirements. Several weeks are required to negotiate and each individual must finance the moderate cost of his own campaign. Retaining fee protected by a refund provision as stipulated in our agreement. Identity is covered and, if employed, present position protected. If you have actually earned over $2,500, send only name and address for details. R. W. Bixby, Inc., 260 Delward Bldg., Buffalo, N. Y. (C. M. E.)

### EMPLOYMENT AGENCY

AMERICAN ENGINEERS SERVICE, Bond Building, Washington. Distinctive personnel proposals: Metallurgical, electro-chemical, ceramic, industries; furnaces, forgings, alloys, glass, cements, compounding, fibre, varnish, viscose products.

### POSITIONS WANTED

CHEMIST or foreman, experienced in chlorine, caustic soda, synthetic ammonia and methanol, rayon, water gas and hydrogen manufacture. B.S. chemist. Age 30 years. Now available. PW-51, Chemical and Metallurgical Engineering, 330 West 42d St., New York City.

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DISTILLERY ENGINEER. Chemical engineer, years' designing experience, alcohol equipment. Very desirous similar, chemical laboratory or operating position in distillery or engineering firm. PW-50, Chemical and Metallurgical Engineering, 330 West 42d St., New York City.

EXECUTIVE, 41, married. Specialized in textile chemicals, color applications. Well versed in all phases related to finished textile products. PW-45, (Agency), Chemical and Metallurgical Engineering, 330 West 42d St., New York City.

MECHANICAL ENGINEER, experienced in construction of non-ferrous metal and alloys. Fluent knowledge of Russian. PW-52, Chemical and Metallurgical Engineering, 330 West 42d St., New York City.

PATENT ATTORNEY, chemist and engineer (M.E., Ph.D.). Ten years' experience in research, development and operation. Five years' patent experience. Can direct profitable research and build valuable patent structure. PW-36, Chemical and Metallurgical Engineering, 330 West 42d St., New York City.

PLANT OPERATION. Practical and experienced chemical engineer. Yale graduate, married, 31. Six years' plant operation mining industries (shift-foreman to plant superintendent). One year factory experience (chemical and physical testing). Excellent operator with unusual ability and high references. Salary secondary. PW-58, Chemical and Metallurgical Engineering, 330 West 42d St., New York City.

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SALES ENGINEER. Graduate engineer, capable of managing district office for firm manufacturing equipment for chemical and allied industries, desires position. PW-57, Chemical and Metallurgical Engineering, 330 West 42d St., New York City.

### POSITIONS WANTED

MECHANICAL ENGINEER, capable taking charge of a copper shop or a contracting shop making equipment from copper and other non-ferrous metals. PW-53, Chemical and Metallurgical Engineering, 330 West 42d St., New York City.

RESEARCH CHEMIST, 37, married. 13 years' experience in laboratory control and plant research in field of pharmaceuticals and heavy chemicals. PW-47, (Agency), Chemical and Metallurgical Engineering, 330 West 42d St., New York City.

### BUSINESS OPPORTUNITY

**Correspondence Solicited**

With parties with capital interested in gold, manganese, tin and coal deposits, also very high grade limestone. Piedmont Engineerng Co., Box 232, Charlottesville, Va.

### AGENTS WANTED

EARN from $1 to $5 an hour extra without interfering with your present employment. Whether office man, salesman, technical man, foreman or worker you can make ready cash quickly and easily each week showing our lists of business and technical books to fellow employees and others. You recommend them, we do the rest. No experience required. Complete equipment free. Write Tom Crawford, Dept. C. & M., McGraw-Hill Book Co., 330 West 42d St., New York City.

**Are You Represented in Chicago?**

Versatile organization with laboratories and service facilities, will negotiate with high-class producer of Chemicals who wishes technical sales representation in Chicago district.

RA-48, Chemical & Metallurgical Engineering
520 No. Michigan Ave., Chicago, Ill.

**IDEAS WANTED**

Financing arrangements available to competent man with necessary knowledge of a process or product having utility or market value. We believe we can arrange financing assuring him profitable participation.

*Write in Confidence*

BO-55, Chemical and Metallurgical Engrg.
330 West 42d St., New York City

**Manufacturing and Laboratory facilities available for new Chemical Products**

Manufacturers, chemists, engineers or others having new products which require manufacturing or laboratory facilities for their development, or additional financing, are invited to address—*Chemlab—"Box BO-933," Chem. & Met. Eng., 330 West 42nd Street, New York City.*

**WANTED**
**CANADIAN MANUFACTURING PROPOSALS**

A Canadian company, already in the chemical manufacturing business, desires correspondence with individuals or companies who may be open to consider the manufacture of their chemical products or chemical specialties in Canada. Advertiser is in a position to offer laboratory and manufacturing facilities and could give sound direction to sales and the management of Canadian business.

Should consideration of any specific proposal indicate the desirability, advertiser is in a position to undertake joint financial responsibility in the development of Canadian companies for the manufacture and distribution of chemical products.

BO-54, Chemical and Metallurgical Eng.
330 West 42d St., New York City

FOR SALE
**DIATOMACEOUS EARTH**

Approx. 300 tons, Fine and Lump Form, mined in Virginia & Maryland. Price $6.00 per ton for complete lot.

**Superior Electric Machinery Co.**
253 North Third Street Philadelphia, Pa.

**WANTED**

USED INDUSTRIAL DIAMONDS
**PLATINUM SCRAP**
IN ANY FORM

We pay highest market price, make prompt returns and hold goods for your approval.

**I. MILLER, Smelter and Refiner**
**304 Colonial Arcade, Cleveland, Ohio**

**WANTED**
**USED FURNACE**

for roasting Zinc, or Lead ore. To handle 25 to 50 tons per day.

W-56, Chemical & Metallurgical Engineering
520 No. Michigan Ave., Chicago, Ill.

*Don't forget the* **Box Number**

WHEN answering the classified advertisements in this magazine, don't forget to put the box number on your envelope. It's our only means of identifying the advertisement you are answering.

# CONSOLIDATED

*Is your plant ready for Recovery?*

## "USED EQUIPMENT" *will meet your budget and help you* GET GOING!

We're in for recovery—definitely! But if you're going to make the most of it you've got to have the equipment to step out and get into the procession. CONSOLIDATED "USED EQUIPMENT" means that you can get such equipment promptly—and yet maintain a cash surplus to meet added payrolls and create added employment.

Find what you need in our large stocks in Newark—then we'll thoroughly and expertly overhaul, recondition or even rebuild it—and ship it to you quickly under guarantee of satisfaction. Buy CONSOLIDATED—and you buy with CONFIDENCE.

***The following items are only a cross-section of our equipment on hand, in Newark or at modern, complete chemical plants in our hands for liquidation. Send for your copy of "Consolidated News" listing fully our large stock of Used Equipment.***

8—**Distillation Units,** 72 in., 60 in., 44 in., 36 in., 30 in., 24 in., 14 in., Badger, Lummus, Ansonia makes, complete with Dephlegmators, Condensers and Still Pots. Also, complete line of automatic and semi-automatic Filling, Labelling, Capping, Conveying and Storage Equipment.
8—**Sweetland Filters,** No. 12, 11, 10, 9, 7, 5, 2, and laboratory size—copper, iron, and monel leaves.
3—**Hardinge Conical Ball Mills,** 6 ft.x22 in., iron lining, herringbone cut cast steel gears; arranged for motor drive.
5—**Atmospheric Drum Dryers,** 4x9 ft. Mechanical; 5x12 ft. Buffalo; 5x13 ft. 6 in. Stokes.
24—**W. & P. Mixers,** jacketed and unjacketed, 2650 gal. to laboratory size.
10—**Devine Vacuum Shelf Dryers,** No. 0, No. 5, No. 11, No. 12, No. 23, No. 26, No. 27, No. 30.
8—**Raymond Pulverizers,** No. 0000 to No. 3; five roll high side roller mills.
1—**Swenson Aluminum Triple Effect Evaporator,** 250 sq.ft. per effect, complete.
3—42-in.x42-in. **Shriver Iron Filter Presses,** plate and frame, 40 chambers, gear closing device.
1—Pfaudler 1000 gal. glass lined **Mixing Tank.**
2—Lake Shore Double Drum **Atmospheric Dryers,** 4x12 ft.
4—**Copper Vacuum Pans,** jacketed, 50, 150 and 500 **gal.**
1—**Vacuum Drum Dryer, Buffalo Foundry,** 5x12 ft. long, complete with receivers, pumps, etc.

### TRUCK DRYER

1—28-Truck Proctor & Schwartz Dryer, 5,760 sq.ft. tray surface, complete.

### LIQUIDATION

**$1,000,000 Tile & Ceramic Plant of the ROSSMAN CORP., Beaver Falls, Pa.**

Seldom has such modern and improved equipment been offered for sale—

**SPECIAL**

6—Abbe 6'x8', silex-lined Pebble Mills, motor driven, with Reduction Gears, Magnetic Brakes and 15 Hp. A.C. Motors.
5—Patterson 36"x48" and 3 Abbe 45"x42", silex lined, motor driven, with Reduction Gears and 5 Hp. A.C. motors.
4—Laboratory Pebble Mills.

Also other equipment so diversified that it should be of real interest not only to the Ceramic Industry but to every type of manufacturing plant.

**Representative on premises. Phone Beaver Falls 601-602.** ***Send for Printed Bulletin listing items in detail.***

4—**Dopp Kettles, jacketed,** 650 gal.
6—**Oliver Filters,** 36x6 in., 3x2 ft., 6x4-6x6 wood and iron—8x8-8x12 ft. iron.
10—**Steel Jacketed Mixers,** 16 ft. long x 27 in. wide x 44 in. deep, open type, ribbon type agitators. 800 gal. each.
2—40-in. **Fletcher Suspended Type Centrifugal Extractors, steel basket,** 15 hp., A.C. motors, annular bottom discharge.
1—Zaremba triple effect **Evaporator,** 1505 sq.ft. per effect.
8—**Rotary Dryers,** 4x20, 5x26, 6x40, 8x60 ft.
10—**Aluminum Jacketed Kettles,** heavy gauge, 200 gal. each.
2—**Mikro Pulverizers,** 24 in., unusued; 24 in. motor driven.
4—Johnson 30x30-in. cast iron, recessed, **Centerfeed,** 60 chambers.
10—**Class "A" Ruggles-Coles Rotary Dryers,** double shell, direct heat, 3x10, 4x20, 4 ft. 6x26, 5x26, 5x30, 6x35, 8 ft. 8 in.x80 ft.
12—**Vibrating Screens,** 2x4, 3x5, 4x5 Tyler; 2x3, 2x4, 3x6 Niagara; Nos. 9, 52, 61 Rotex.
9—**Rotary Vacuum Dryers,** 2x4 ft. Devine; 2x6 ft. Stokes, Devine; 3x10 ft. Buffalo; 3x15 ft. Devine, Stokes; 3x25 Devine, 5x15 ft. Buffalo; 5x25 ft. Devine; 5x33 ft. Devine, complete with pumps and condensers.
3—**Autoclaves;** 2—150 gallon, full jacketed, agitated; 1—600 gallon jacketed, agitated.
1—40 kw. **Electric Oil Heating System,** complete with pumps, motors, automatic control switchboard.

### ROTARY STEAM DRYERS

2—6 ft.x35 ft. Louisville Rotary Hot Air Dryers, complete with coils, fans, feeders, etc.
16—6 ft.x30 ft. Rotary Steam Tube Dryers, similar Louisville, 4-in. tubes, complete.

**Send for Consolidated News listing our complete stock of Filter Presses, Dryers, Kettles, Evaporators, Pulverizers, Crushers, Mixers, Vibratory Screens, Distillation Units, Boilers, Pumps, etc.**

**REMEMBER—WE BUY YOUR IDLE EQUIPMENT FOR CASH, SINGLE ITEMS OR COMPLETE PLANTS**

## CONSOLIDATED PRODUCTS CO., Inc.

15 PARK ROW, NEW YORK CITY Shops: 335 Doremus Ave., NEWARK, N. J.

TEL. BARCLAY 7-0600 *"Every machine in your plant is a used machine"* CABLE ADDRESS: EQUIPMENT

*Buy with* CONFIDENCE··*buy* CONSOLIDATED

# BIG SAVINGS

*Used Chemical and Industrial Machinery*

**DRYERS**

2—Devine Rotary Vacuum Dryers, 5x33 ft., complete with condensers and pumps.
2—Devine Vacuum; 13 shelves.

**HORIZONTAL MIXERS**

3—8 gal. Colton Mixers.
2—8 gal. W. & P. Mixers.
4—50 gal. Day Mixers.
2—100 gal. Day Mixers.
1—150 gal. Day Mixers.
2—200 gal. Day Mixers.
1—300 gal. Day Mixer.

**AIR COMPRESSORS**

Large stock of standard makes and sizes.

**VACUUM PUMPS**

Large stock of standard makes and sizes.

**LIQUID PUMPS**

Large stock of steam drive, belt drive and motor driven pumps of standard makes, types and sizes.

**MISCELLANEOUS**

Electric Motors.
Storage, Pressure and Receiver Tanks, from 60 gals. to 12,000 gals.
Pot Stills and Recovery Equipment.
Patent Stills.
Dephlegmators and Condensers.
Rectifying Columns.

**Machinery & Equipment Co., Inc.**

Office, Warehouse and Yards
429-437 Frelinghuysen Ave., Newark, N. J.
Tel. Bigiow 3-5050 and 5051.

# See FIRST first!

F M C

*Partial List of Equipment*

DRYERS FILLERS
FILTER PRESSES
GLASS LINED TANKS
ALUMINUM KETTLES
COPPER KETTLES
PASTEURIZERS
LABELERS, ETC.

*Everything Needed for the Manufacture of*

WINES & LIQUORS

Rinsers ● Filters
Cappers ● Labelers
Conveyors ● Stills
Agitators ● Kettles

Our engineering department will gladly estimate on any special equipment.

**GUARANTEE—All equipment is sold subject to a guarantee that means protection to you. No misrepresentation. All equipment is mechanically perfect.**

**FIRST MACHINERY CORP., 419 Lafayette St., N. Y. City**

*Members of "National Institute of Used Machinery and Equipment Dealers"*

# PRICED FOR QUICK SALE!

**DRYERS**
2 shelf Stokes 18x12 (Lab.)
20 shelf Devine, 40x43.
2x4, 2x6, 4x20 Rot. Vacuum.

**FILTER PRESSES**
10-in. Sperry, 5 chambers. (Lab.)
12-in. Shriver, 12 chambers, aluminum.
30-in. Sperry, 20 plates.
30-in. Wood, 36 chambers.
6x6 Oliver, Continuous.

**VACUUM PANS**
42-in. Pfaudler, glass lined.
8-in. dia. Copper with Cond. (Lab.)
34-in. dia. Copper with cond. and pump.
84-in. dia. Copper with cond. and pump.

**TANKS (Glass Lined)**
200 gal. Pfaudler, agit.
200 gal. Pfaudler, jkt., agit.
500 gal. Pfaudler, jkt., agit.
600 gal. Pfaudler, 78x30.
4—800 gal. Pfaudler, 66x54.
2—1800 gal. Elyria, 66x120.

**VACUUM PUMPS**
6x4 Devine, with 5-hp. motor.
12x6 Ingersoll Rand Type 15.
7x8½x7 Buffalo, steam driven.

**AIR COMPRESSORS**
6x6 Gardner, 15-hp. motor.
10x8 Pennsylvania, 20-hp. motor.
16x12 Gardner, 50-hp. motor.

**ROBT. P. KEHOE MACHINERY CO.**

One East 42nd Street, New York City
Main Warehouse and Yard, 730-736 E. 141st St.
Cable Address: Kehoeinc Telephone: Vanderbilt 3-9595

# BIG SAVINGS

*Used Chemical and Industrial Machinery*

Processes and Complete Plants for the Manufacture of:

Alcohol
Whiskies
Brandies
Cordials
Alcoholic Beverages
Solvent Recovery

Our experienced engineering staff can furnish estimates and designs for complete plants or for enlarging plants. Processes developed and improved.

**Machinery & Equipment Co., Inc.**

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# EQUIPMENT FROM U. S. CHEMICAL WARFARE, EDGEWOOD ARSENAL

**PUMPS**

3—12-in. **Allis Chalmers Centrifugal Pumps,** Motor Driven, 5,000 g.p.m.
1—16-in. **Hill Centrifugal Pump,** Motor Driven.
5—8½-in.x10-in. **Worthington Deane Vertical Triplex Pumps.**
7—7-in.x10-in. **Worthington Deane Vertical Triplex Pumps.**
3—10-in.x10-in. **Worthington Deane Vertical Triplex Pumps.**

**TANKS**

10—9 ft. wide x 10 ft. high **Vertical Tanks** with Cast Iron Legs—Head and Bottom Convex.

**MOTORS**

4—200 hp., 3 bearing, Gen. Elec. 60 cy., 3 ph., 2200 v., 450 r.p.m., sl. rg., complete with switchboard and starting equipment. Never been used.

**CONTAINERS**

500—One ton **Chlorine Containers.**

**All items practically new. Priced to sell.**

**UNITED IRON & METAL CO., Inc.**
**Catherine & B.&O. R.R., Baltimore, Md.**

## FOR SALE

600 ft. 20 in. 4 Ply Himmelstein Bailey Rubber Covered Conveyor Belt, like new.
70—Rex Stearn Roller Bearing Carrying Idlers.
40—Rex Stearn Roller Bearing Return Idlers.
10—New Gardner Vacuum Compressors, 4½ by 3½, Belt Driven.
1—Nichols Herreshoff Roasting Furnace, 12 Hearth, complete with Blowers, Gas Blower, and Speed Reducer; like new.
1—No. 2 Chambers Clay Disintegrator Crusher, Type PD 122, 16 in., and one Chambers Pug Mill; like new.

**SUPERIOR ELECTRIC MACHINERY CO.**
253 NORTH THIRD ST., PHILADELPHIA, PA.

# BARGAINS

4—100-gallon **W. & P. Mixers.**
2—6-gallon **W. & P. Mixers.**
10—**Evaporators**—all sizes and types.
6—**Vacuum Chamber Dryers.**
23—**Filters and Filter Presses.**
18—**St. Jac. Copper and Aluminum Kettles.**
1—**Bliss Carton Sealer.**

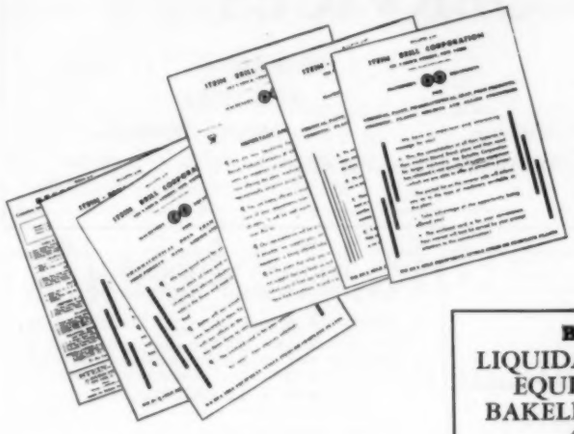
**Send us your inquiries for good used process equipment. Also tell us what you have for sale.**

**Loeb Equipment Supply Co.**
618 West Lake Street, Chicago

# Somewhere

*there's a buyer for the Equipment you no longer need. Reach him thru an advertisement in the* SEARCHLIGHT SECTION.

# A DIVERSIFIED LINE *of* EQUIPMENT



***. . . . to serve the Process Industry***
***Send for complete bulletin containing the kind of equipment you need***

**BULLETIN 101**

CHEMICAL INDUSTRIES

*——A Few Specials ——*

5—No. 12 Sweetland Filters.
9—Oliver Rotary Filters, 4x6 ft., 6x4 ft., 6x6 ft.
12—Shriver Filter Presses, 24 in., 30 in., 36 in., 42 in.
15—Centrifugals, 24 in., 30 in., 36 in., 40 in., 48 in. baskets.
12—W. & P. Mixers. From 1 gal. to 580 gals.
35—Grinders, Pulverizers; Raymond, Jay-Bee, Gruendler, Sturtevant, etc.
1—Ruggles-Cole 4 ft.x30 ft. Rotary Dryer.
5—Devine Vacuum Shelf Dryers.
2—Devine Rotary Vacuum Dryers, 3 ft.x15 ft., 4 ft.x20 ft.
5—Louisville 6 ft.x25 ft. Rotary Steam Tube Dryers.

Tanks, Kettles, Pumps, Compressors, etc.

**BULLETIN 102**

LIQUIDATION OF SURPLUS EQUIPMENT OF THE BAKELITE CORPORATION

*——A Few Specials ——*

15—Powder Mixers, 600 to 3000 lbs.
4—6 ft.x5 ft. Abbe Pebble Mills.
3—Rotex Sifters.
2—6 ft. Buffalo Vacuum Crystallizers.
5—20 in. and 22 in. Schutz-O'Neill Mills.
6—No. 0000 Raymond Mills.
Pumps, Motors, Kettles, etc.

**BULLETIN 103**

Liquidation of
THE ALTON BARIUM PRODUCTS CO.
Alton, Illinois

OVER $800,000 WORTH OF CHEMICAL MACHINERY

*—A Few Specials—*

5—Allis-Chalmers Bruckner type Rotary Furnaces, 6 ft. 6 in.x 15 ft.
1—Nedge 7 Hearth Mechanical Furnace.
1—Mackintosh 30 in. direct motor driven, rubber lined Centrifugal.
3—500-1300 cu.ft., steam driven Air Compressors.
150—25 cy., 440 v Motors, 1 hp. to 150 hp.
30—Cypress Wood Tanks, 9 ft.x 8 ft.
30—Steel Tanks, 1,500 to 12,000 gal.
2—500 hp. O'Brien water tube Boilers, 175 lbs. pressure.

**BULLETIN 104**

PHARMACEUTICAL—FOOD PRODUCT INDUSTRIES

Mixers — Kettles
Grinders — Filters
Dryers — Pumps
Powder Mixers
Powder Fillers
Tube Filling Machinery
Bottle Filling Equipment
Tablet Machinery
Stills, Rectifiers
Etc., Etc.

**BULLETIN 105**

PAINT, VARNISH, INK INDUSTRIES

Pebble Mills — Stone Mills
Roller Mills — Paste Mixers
Iron Mills — Liquid Mixers
Pony & Change Can Mixers
Clarifiers and Filters
Etc., Etc.

**BULLETIN 10**

SOAP INDUSTRIES

Presses — Slabbers
Dryers — Mills
Crutchers — Kettles
Plodders — Filters
Frames — Cutting Tables
Chilling Rolls
Wrapping Machinery
Etc., Etc.

## Our 2-Way Service

STEIN-BRILL offers a vast amount of used equipment in fine serviceable condition.

In addition our organization will act as exclusive sales agents for your surplus equipment.

This 2-way service is such that the seller is not forced to sacrifice in order that the buyer may purchase economically. (See pages 142-143 in the November issue of Chemical and Metallurgical Engineering.

**Single Units or Complete Plants Bought for Cash**

# STEIN-BRILL CORPORATION

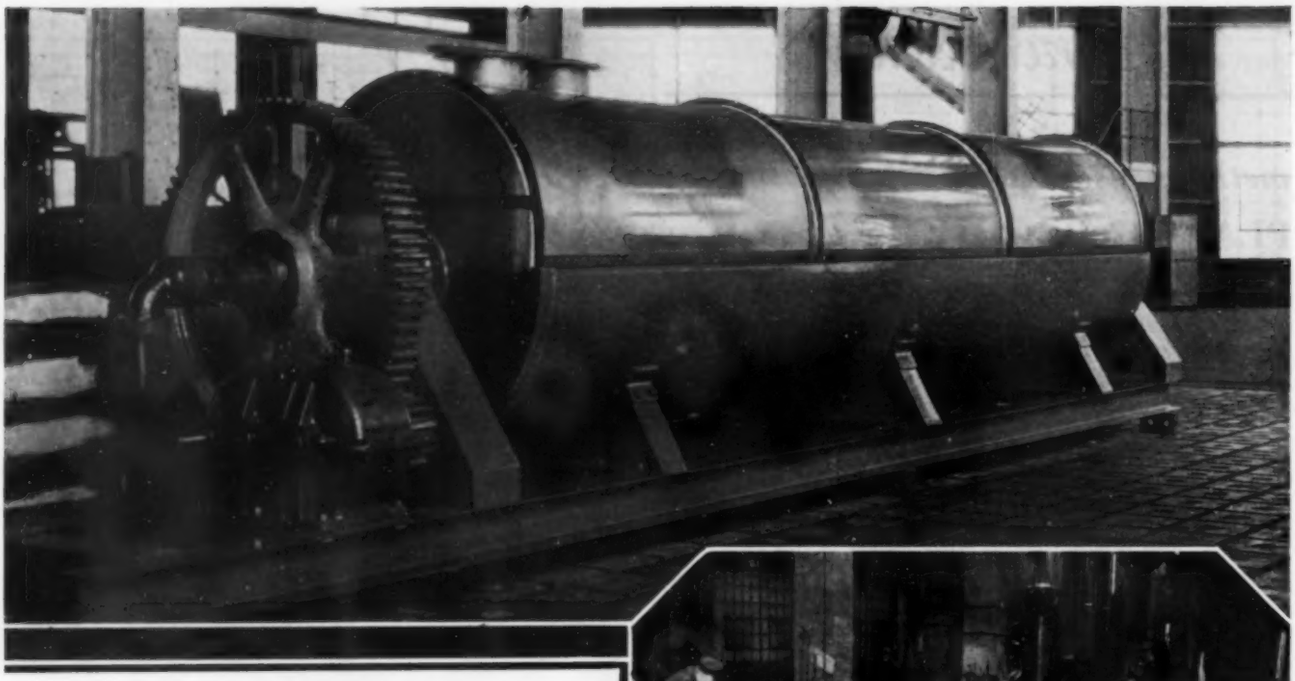
*MEMBERS OF "NATIONAL ASSOCIATION OF USED MACHINERY & EQUIPMENT DEALERS"*

**183 Varick Street** — **New York City**

# PROFESSIONAL SERVICES

PATENTS · PACKING · TESTING · PLANT DESIGN · INVESTIGATIONS · GENERAL CONSULTING · RESEARCH · PROCESSES · MANAGEMENT

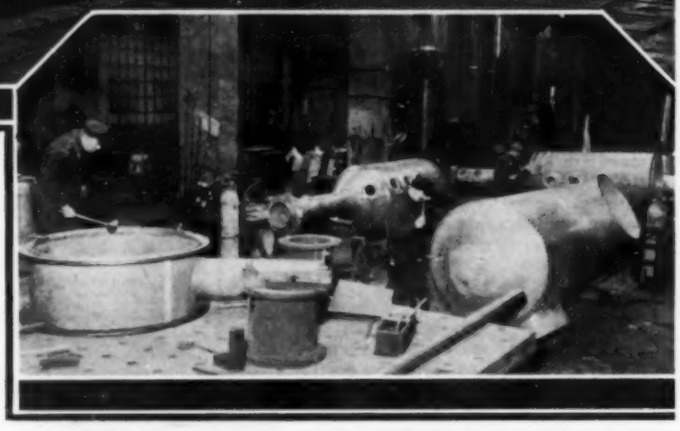
CHEMICAL, BACTERIOLOGICAL AND NUTRITIONAL ANALYSIS



BUFLOVAK spent grains dryer

BUFLOVAK

# DISTILLATION EQUIPMENT



A distillation unit being fabricated in the BUFLOVAK copper shop.

## *built by an organization that knows*

## DESIGN—CONSTRUCTION—INSTALLATION

THE BUFLOVAK organization has complete facilities for the design, fabrication and erection of distillation equipment. This includes apparatus for batch and continuous operation for the manufacture and refining of a great variety of industrial chemical products. Also complete distillation plants for the production of all grades of alcohol for either industrial or beverage purposes, including equipment for fermentation and the utilization of spent grains and slop.

Modern manufacturing facilities are available to shorten deliveries as quickly as consistent with sound construction. This is an important condition which prudent buyers should carefully investigate.

*New* BUFLOVAK LITERATURE

Complete Catalog No. 275
Brewhouse Equipment No. 274
Processing Kettles No. 276

BREWHOUSE EQUIPMENT

DISTILLATION APPARATUS

*DRYERS

*EVAPORATORS

*IMPREGNATORS

*FUMIGATORS

*VULCANIZERS

*CHEMICAL PLANT EQUIPMENT

CHEMICAL CASTINGS

*Fabricated wherever practicable from any of the new materials of construction.

## BUFFALO FOUNDRY & MACHINE CO.

1551 Fillmore Ave., BUFFALO, N. Y.

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In Canada: BUFLOVAK COMPANY OF CANADA, LIMITED, 1101 Permanent Canada Bldg., Toronto

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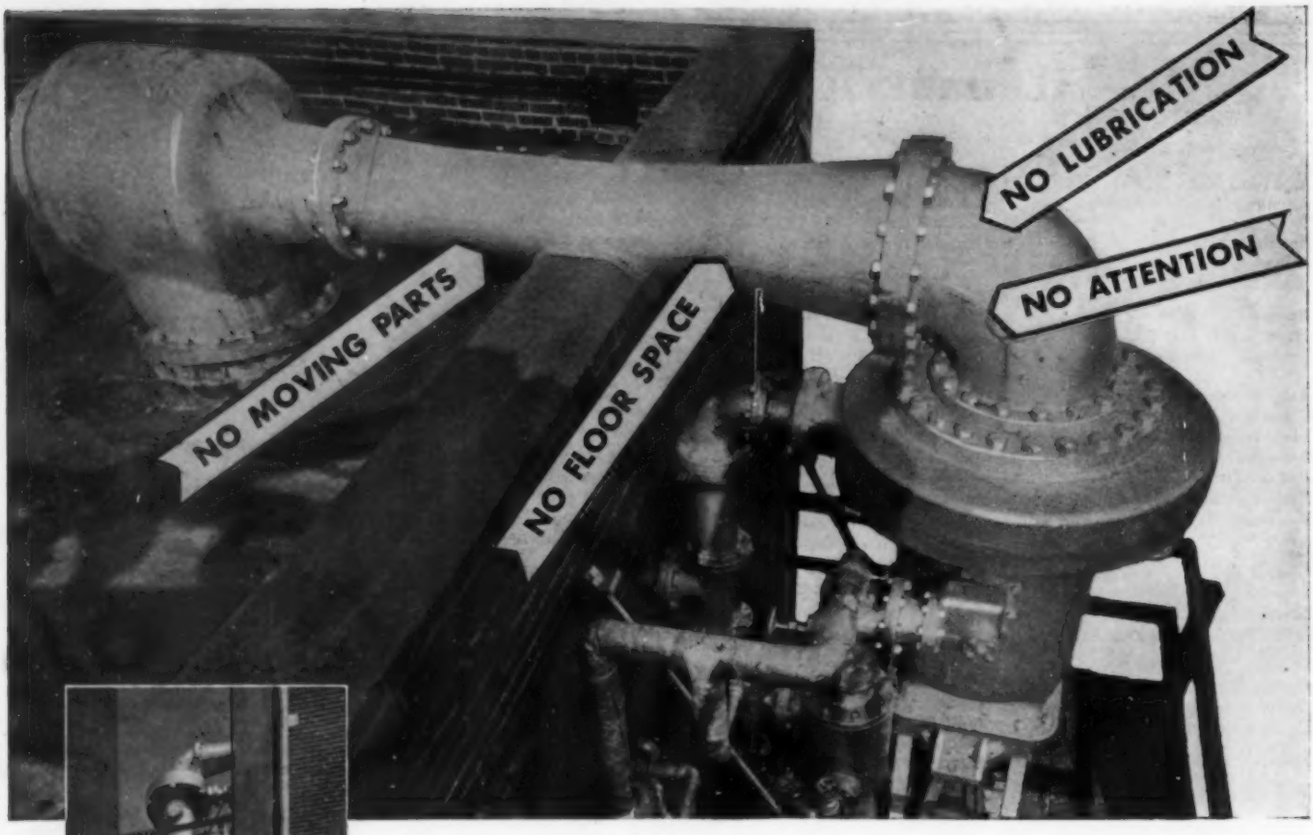


# You can put your vacuum pump ON THE ROOF... if it is an ELLIOTT STEAM JET EJECTOR

The photos show a typical installation of Elliott steam jet vacuum-producing equipment. It serves a large vegetable oil deodorizer inside the building. The unit consists of a booster ejector discharging into a barometric type intercondenser, served by a two-stage ejector. It produces a vacuum in the deodorizer of 29.8", when handling the blowing steam injected into the deodorizer. All it needs is steam and condensing water. No moving parts. No lubrication, no floor space, and practically no attention required.

Elliott ejectors get results no other method of vacuum production can equal—in high vacuum obtained economically on large units. Elliott ejector equipment can be designed to maintain practically any vacuum.

If you haven't investigated the possibilities of Elliott vacuum-producing equipment, you perhaps do not know how economically high vacuum can be produced. Let us get down to cases, and discuss with you your vacuum needs.

## UNFAILING PERFORMANCE

is characteristic of Elliott equipment which includes: Steam turbines and engines, generators and motors, condensers, feed-water heaters and deaerators, centrifugal blowers and compressors, strainers, desuperheaters, filters and grease extractors, non-return valves.

G-318

**ELLIOTT COMPANY**
PITTSBURGH, PA.
*Heat Transfer Department* JEANNETTE, PA.
*District Offices in Principal Cities*

PIONEERS IN THE DESIGN, CONSTRUCTION AND APPLICATION OF STEAM JET EJECTORS